Spatial Patterns in Gold Deposits for the Bendigo-Ballarat Region Victoria, Australia

PowerPoint 6-5

Prepared as part of:

The Spatial and Temporal Distribution of the Metal Mineralisation in Eastern Australia and the Relationship of the Observed Patterns to Giant Ore Deposits

by
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PhD

THE UNIVERSITY
OF QUEENSLAND
AUSTRALIA

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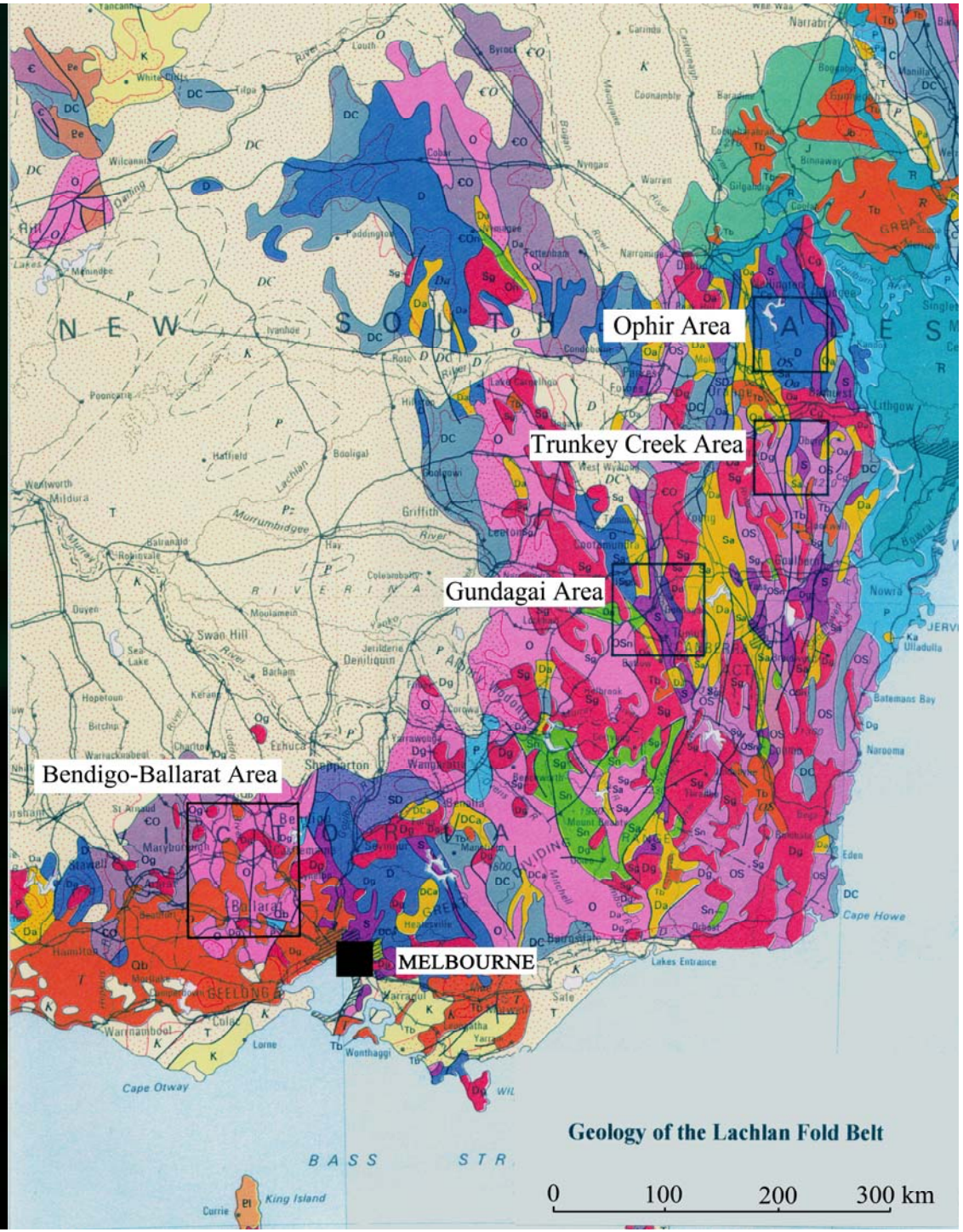
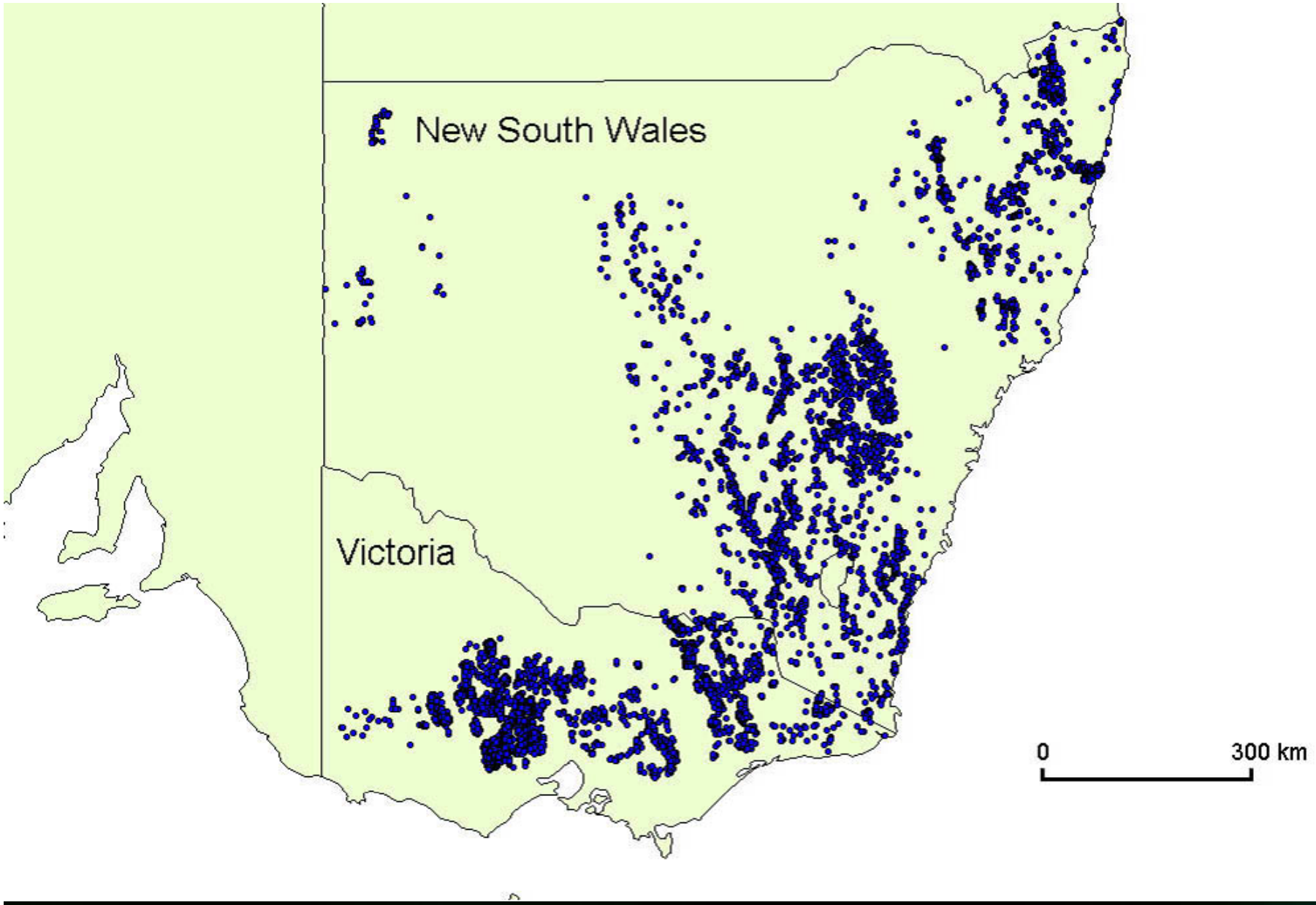
Geology of Southeastern Australia, The Lachlan Fold Belt[1]

Between 1851 and 1895, the Bendigo-Ballarat Goldfields produced more gold than any other goldfield in the entire world. The Bendigo-Ballarat area has produced ~2,000 tonnes of gold.

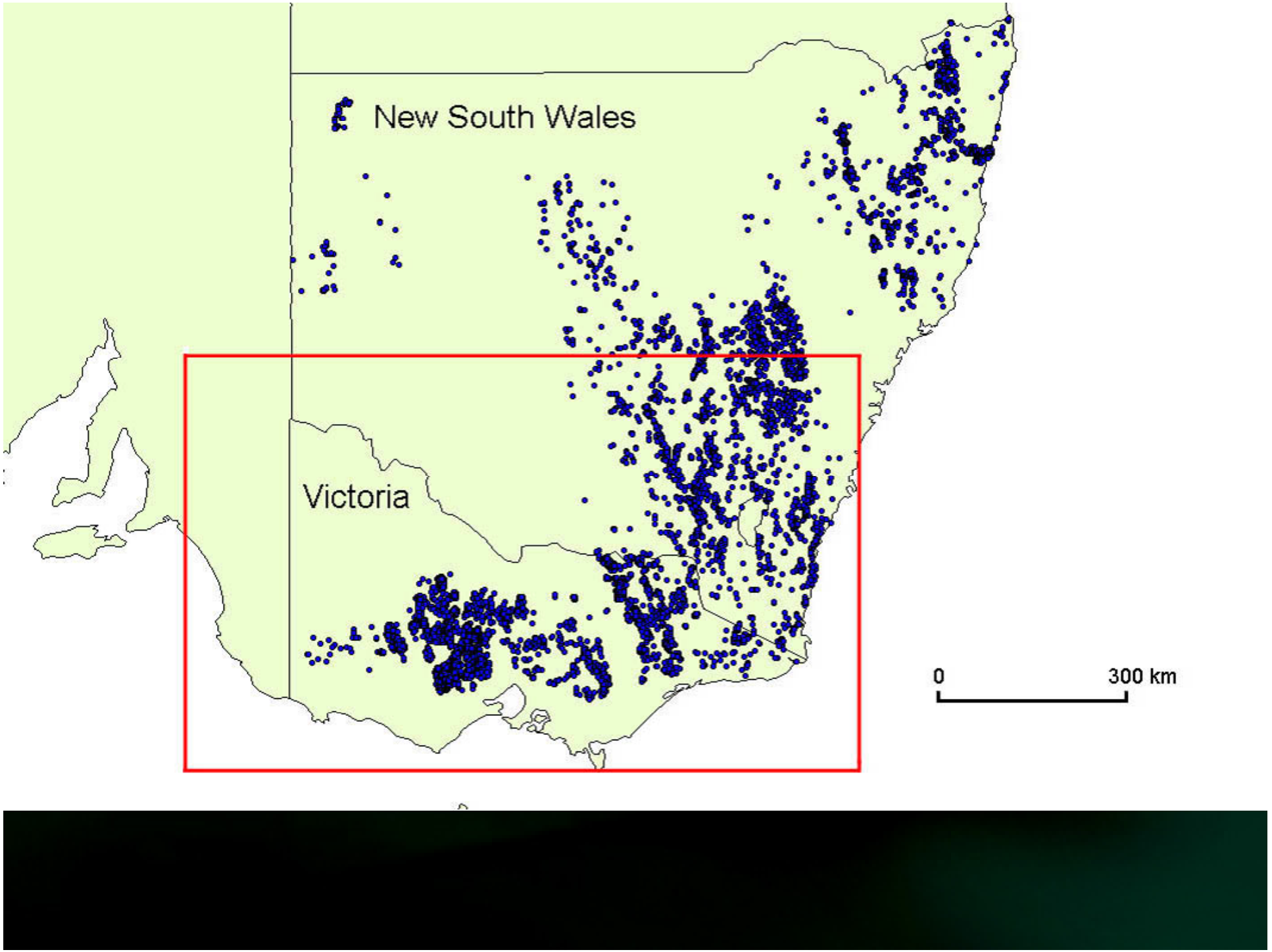


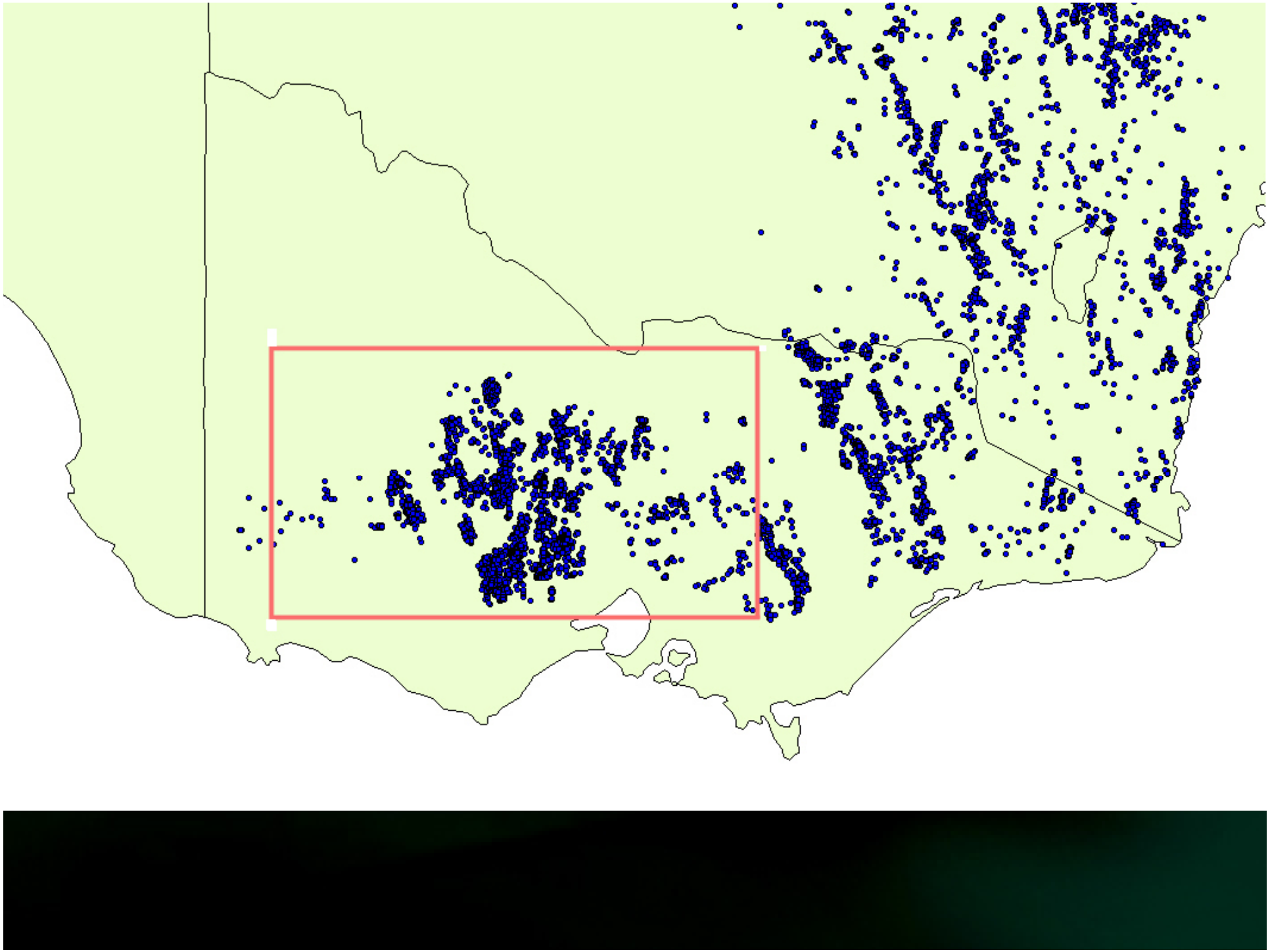
There are clusters within clusters for the gold deposits of southeastern Australia.

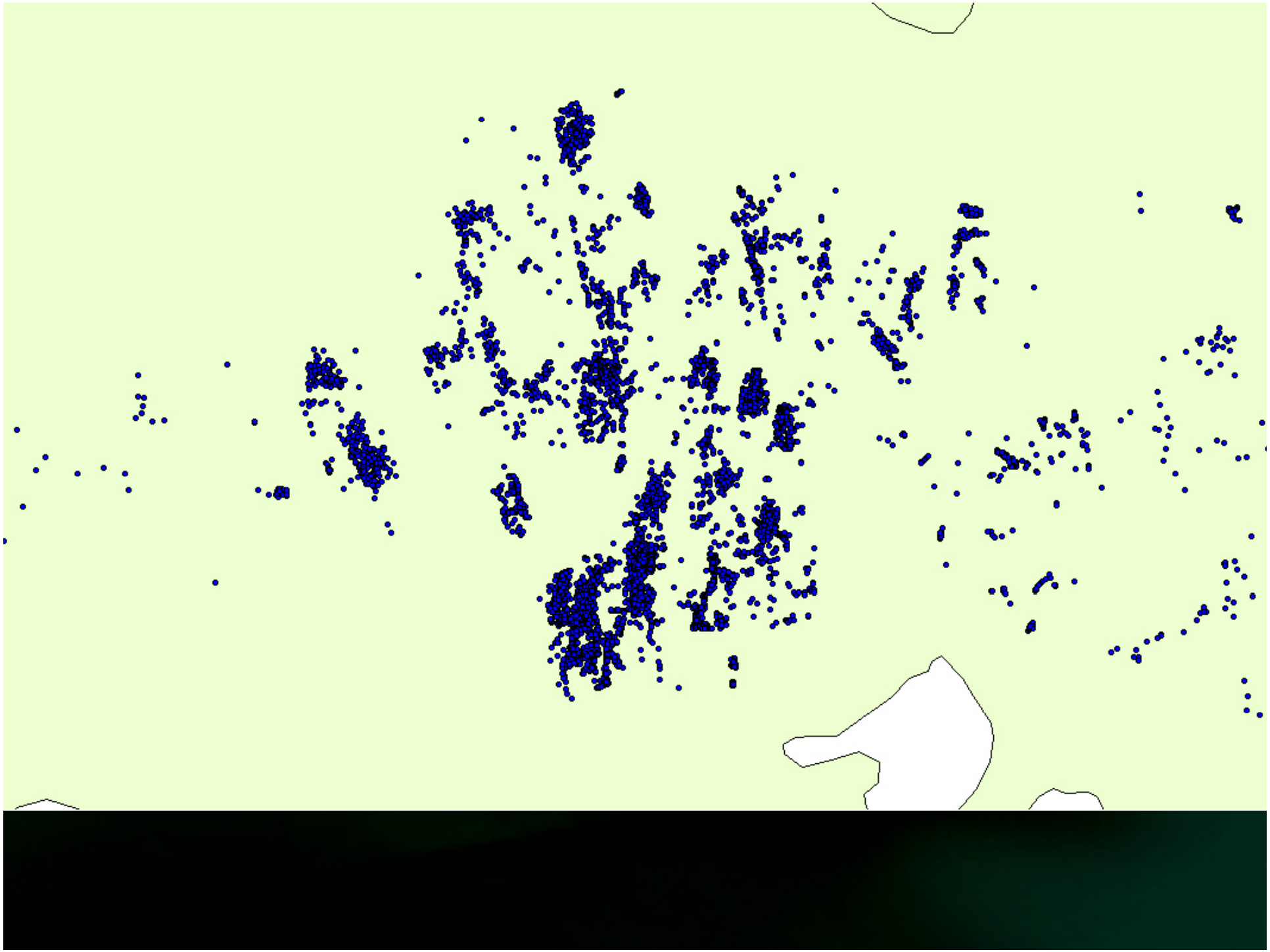
Patterns within patterns.

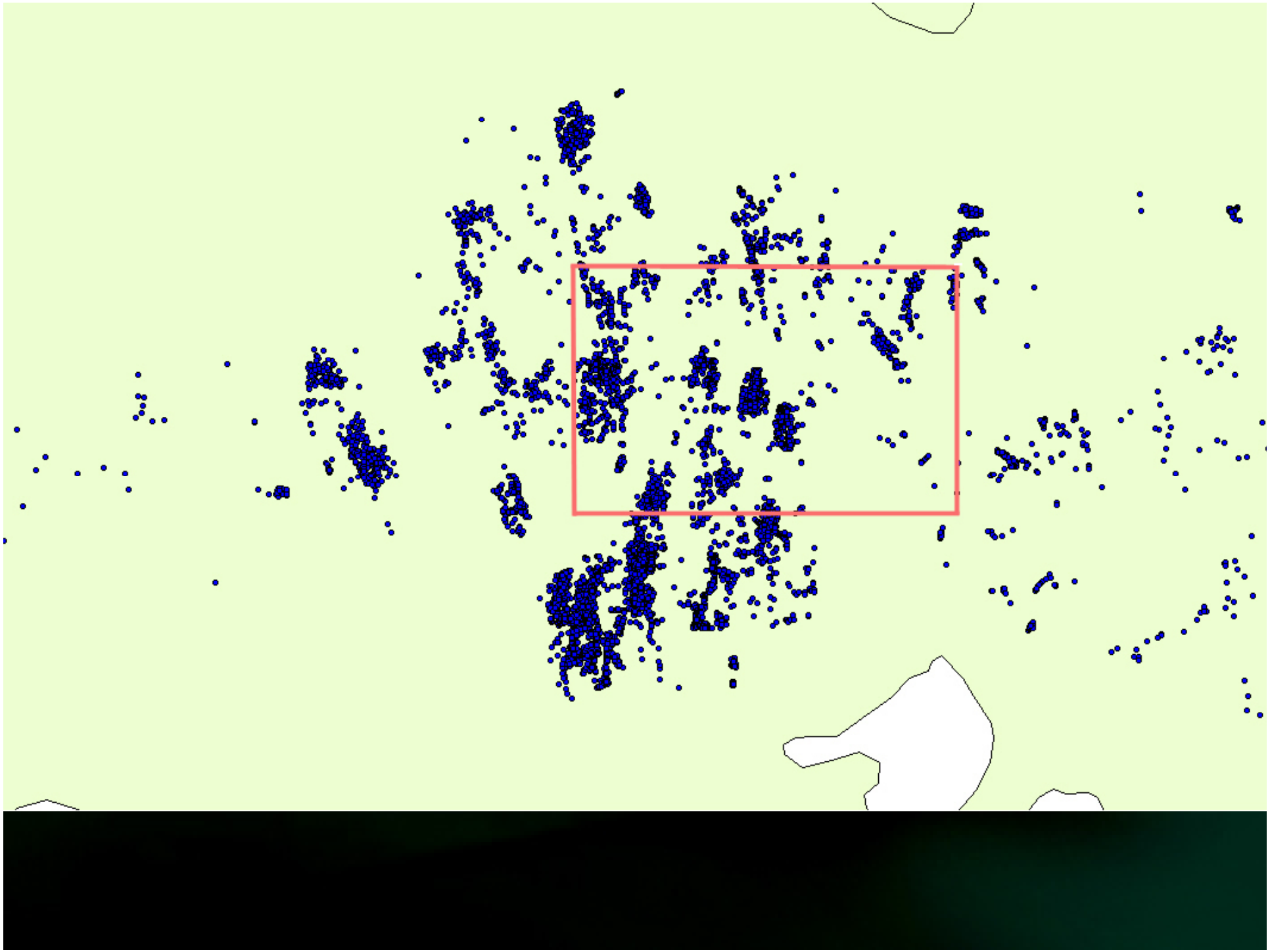


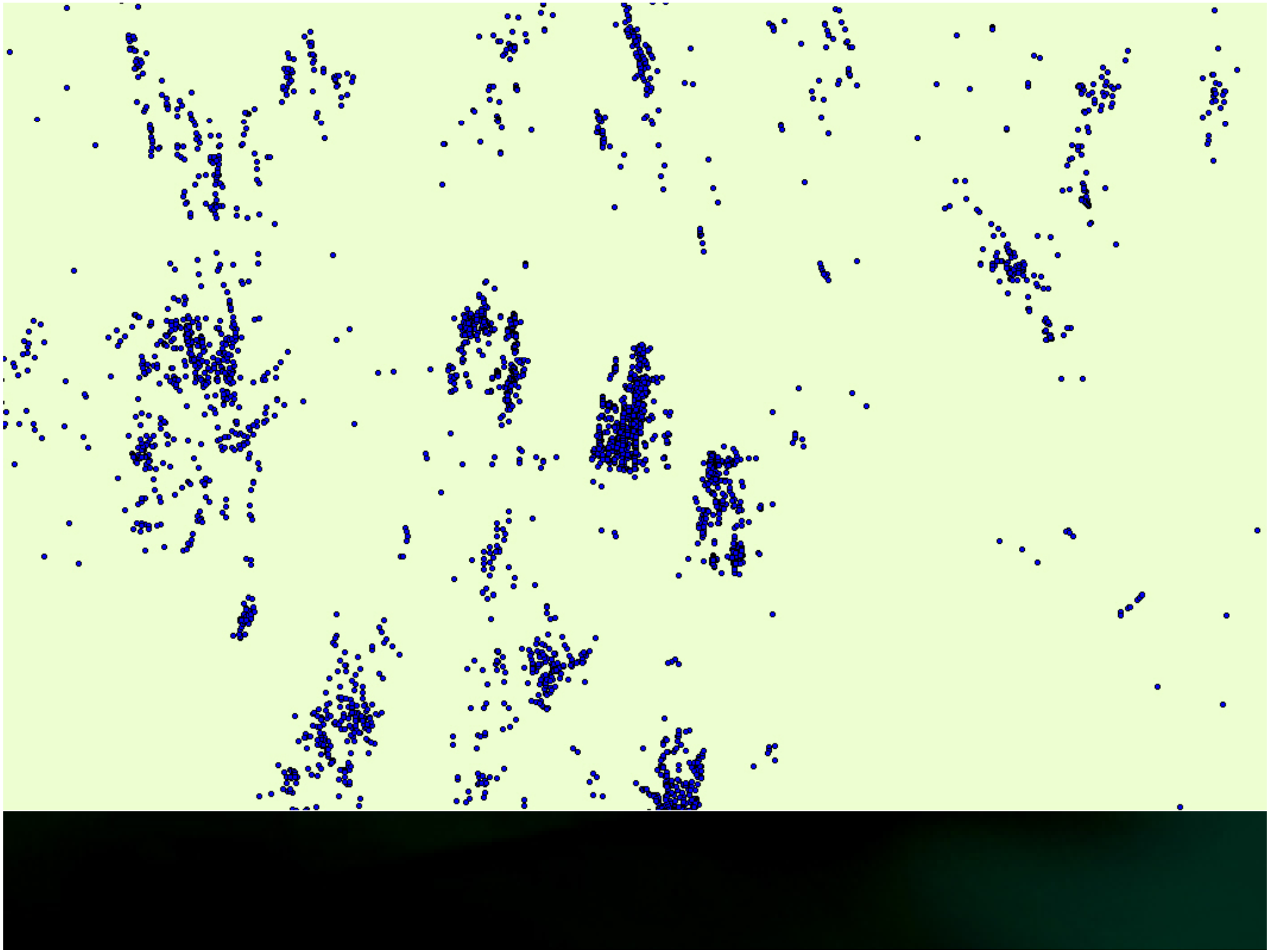
The gold deposits of southeastern Australia.[2&3]

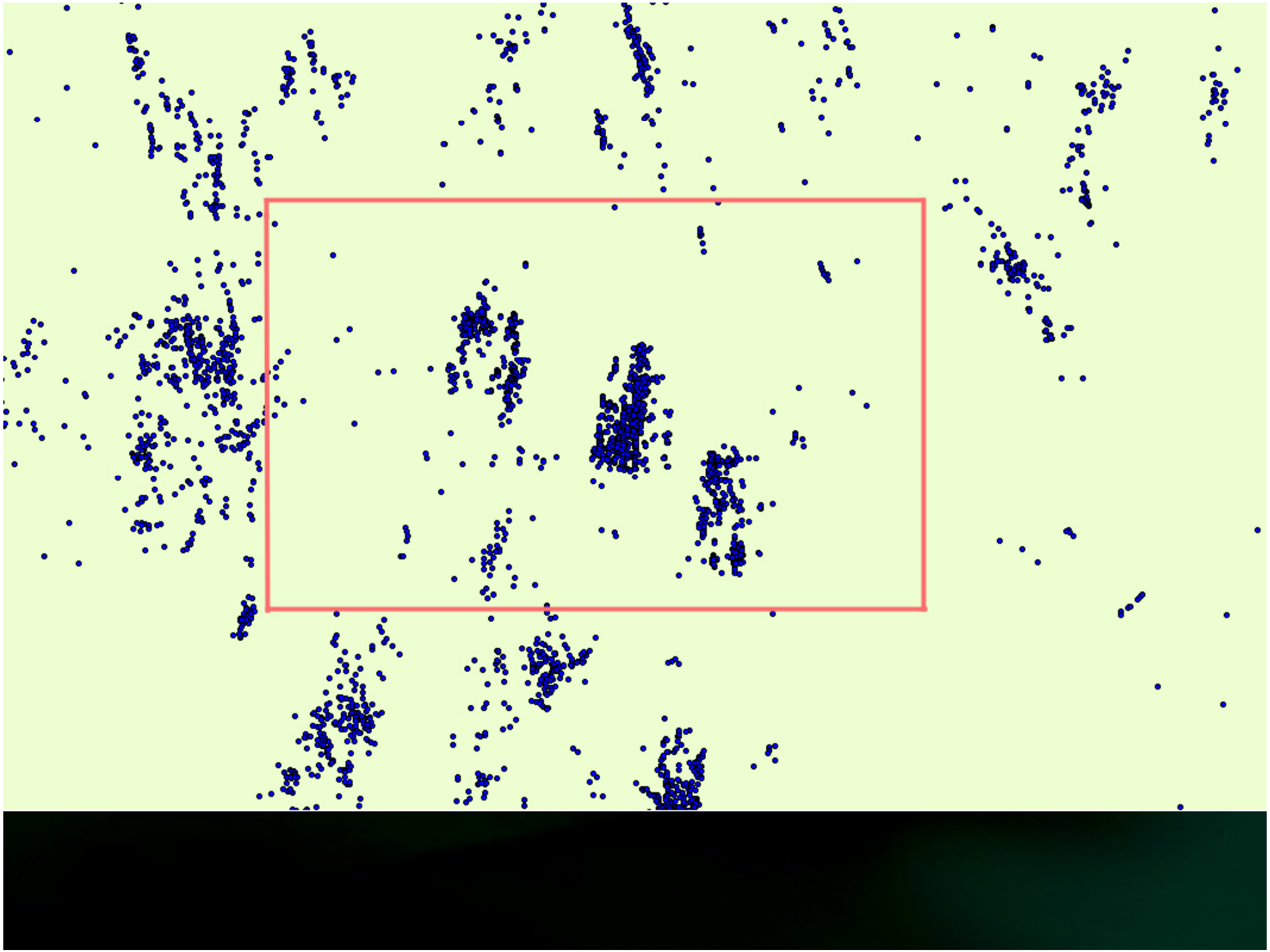

New South Wales
Victoria
0
300 km

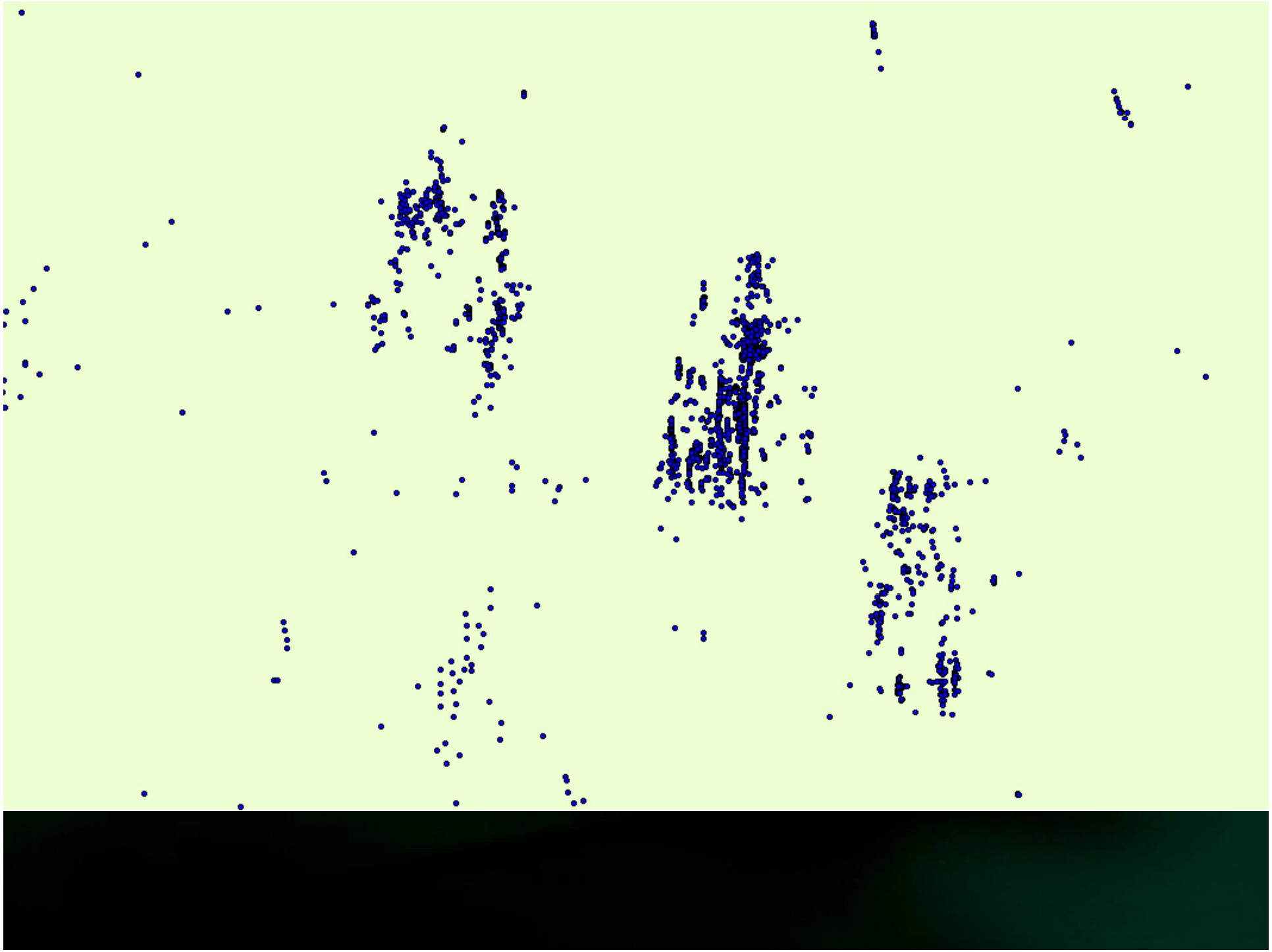


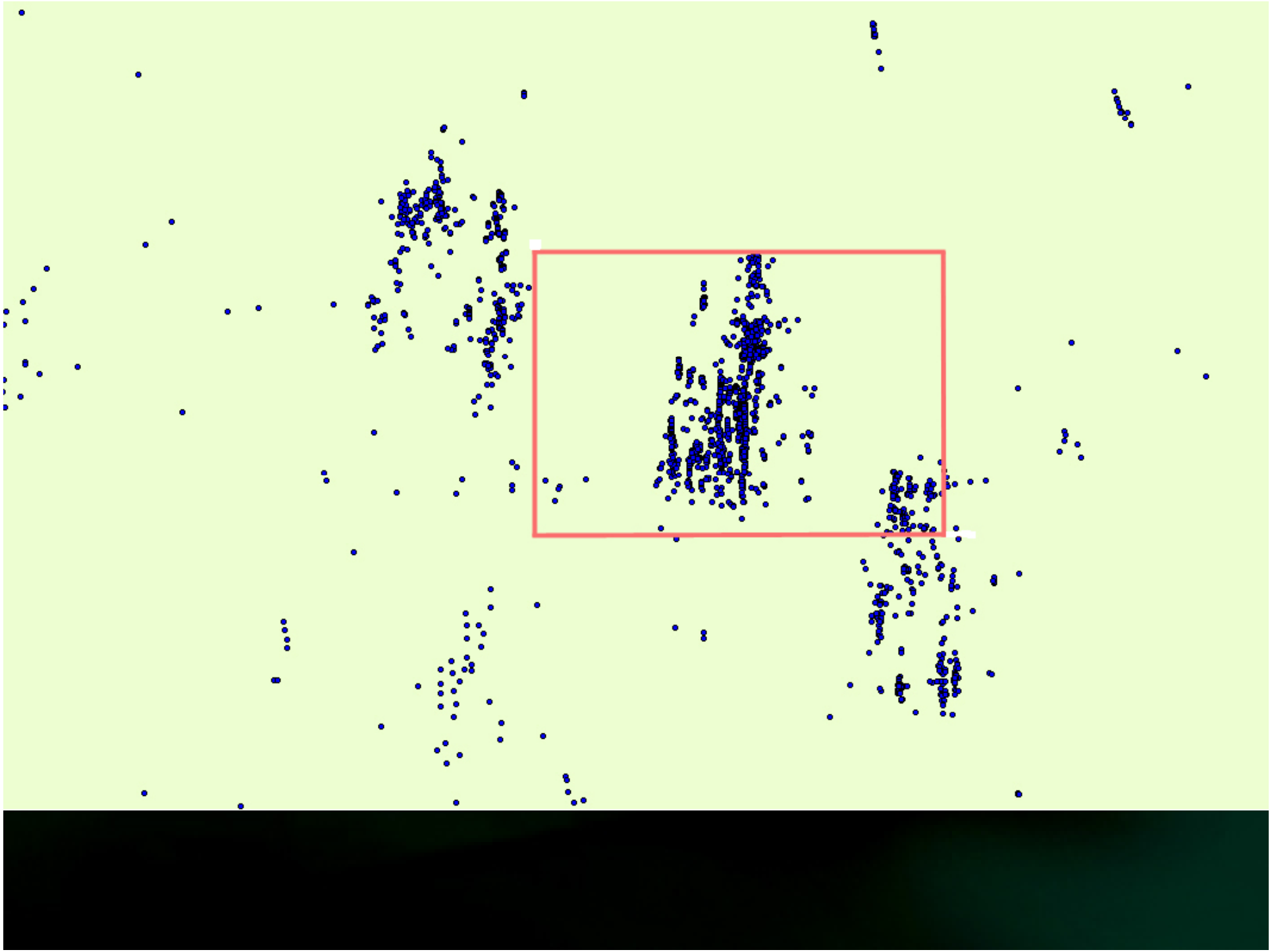


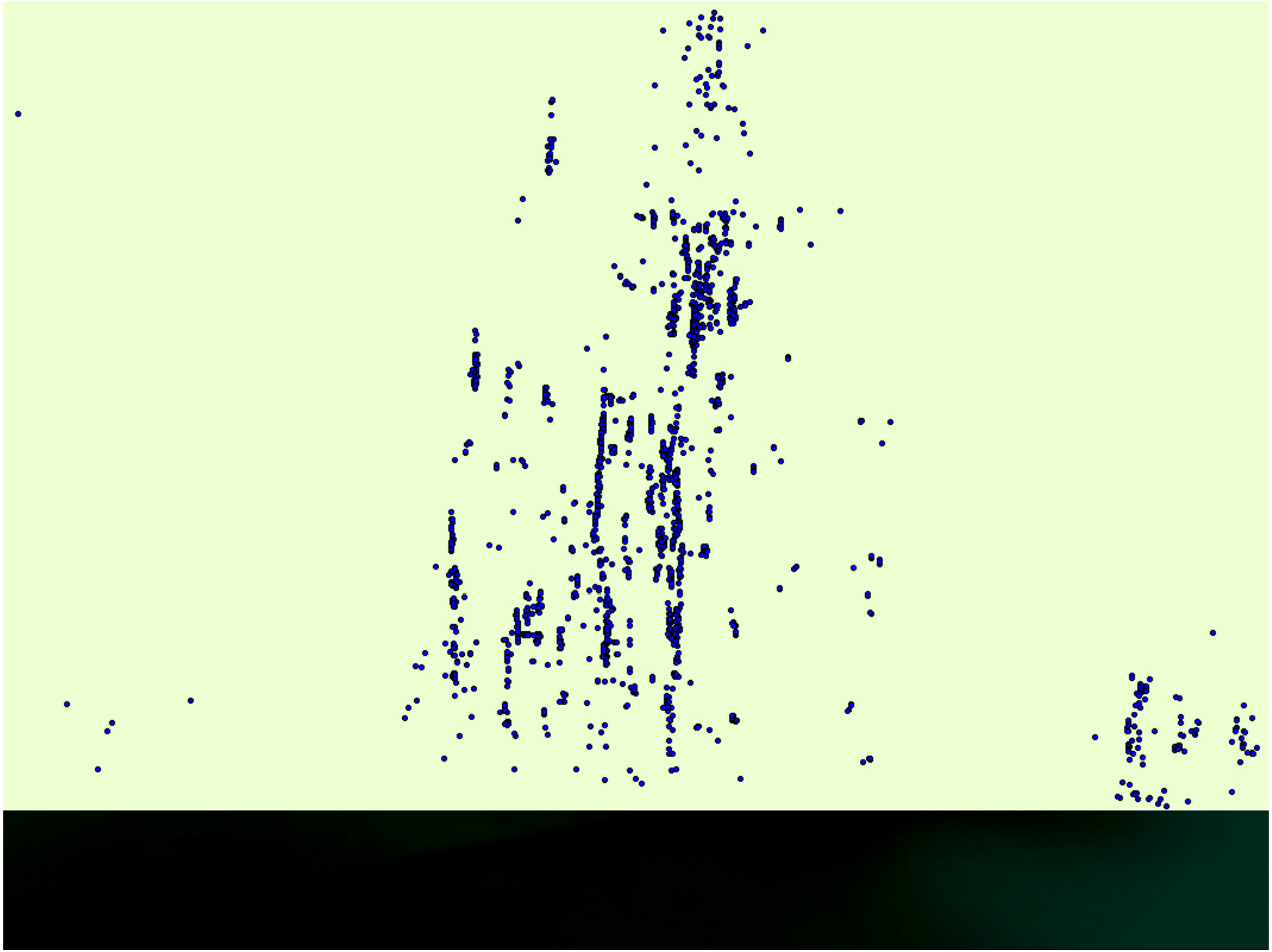


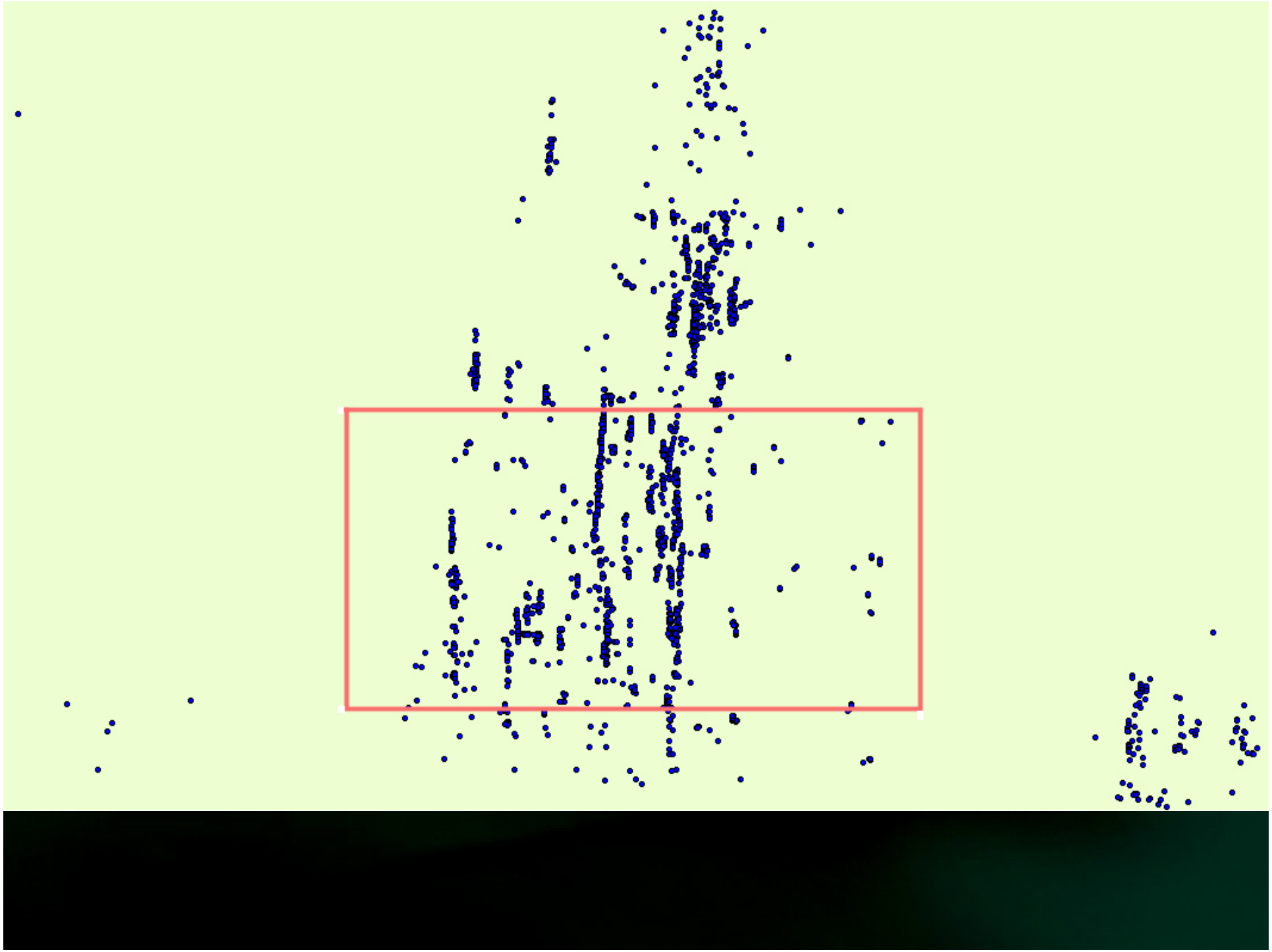


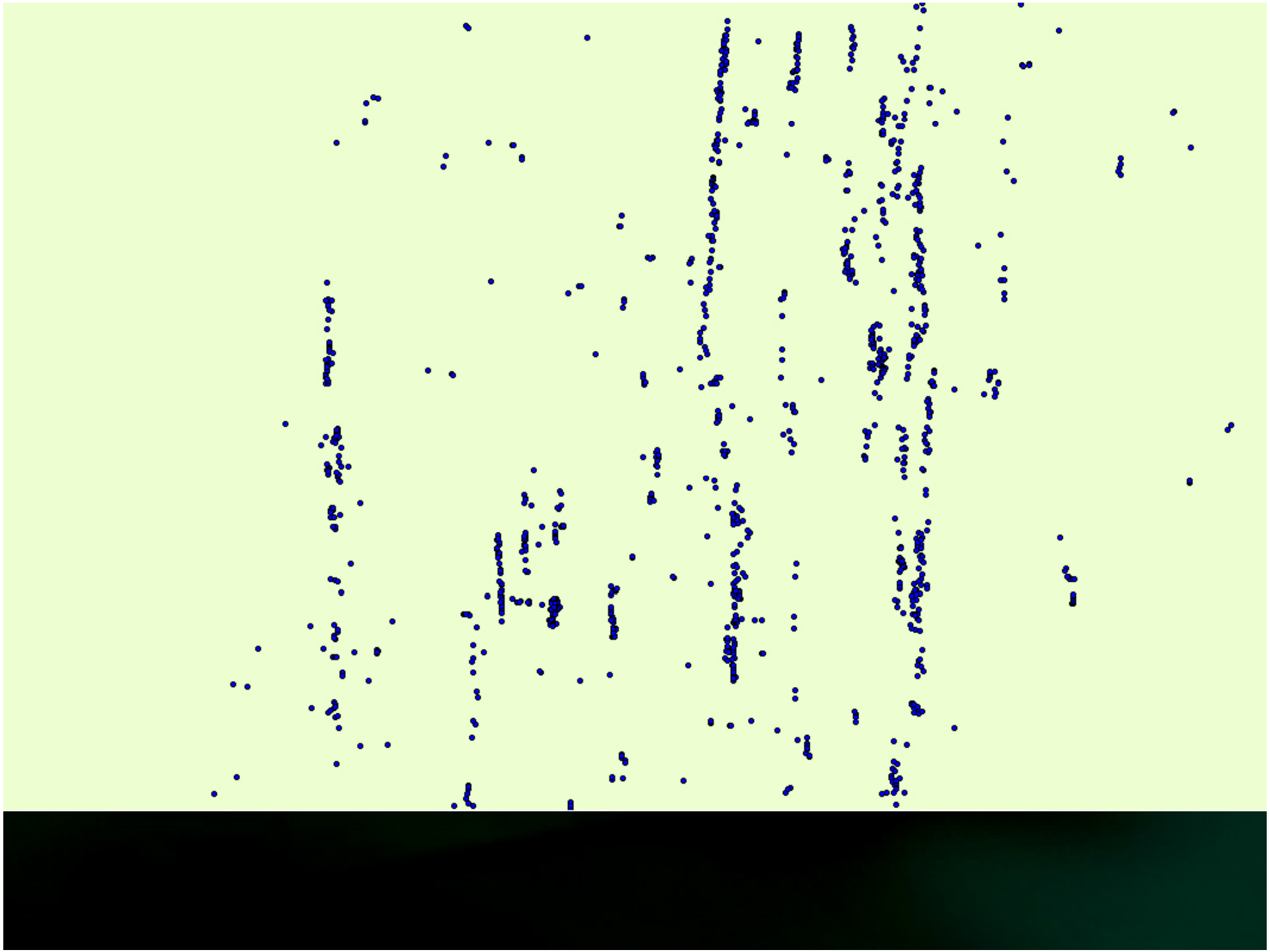


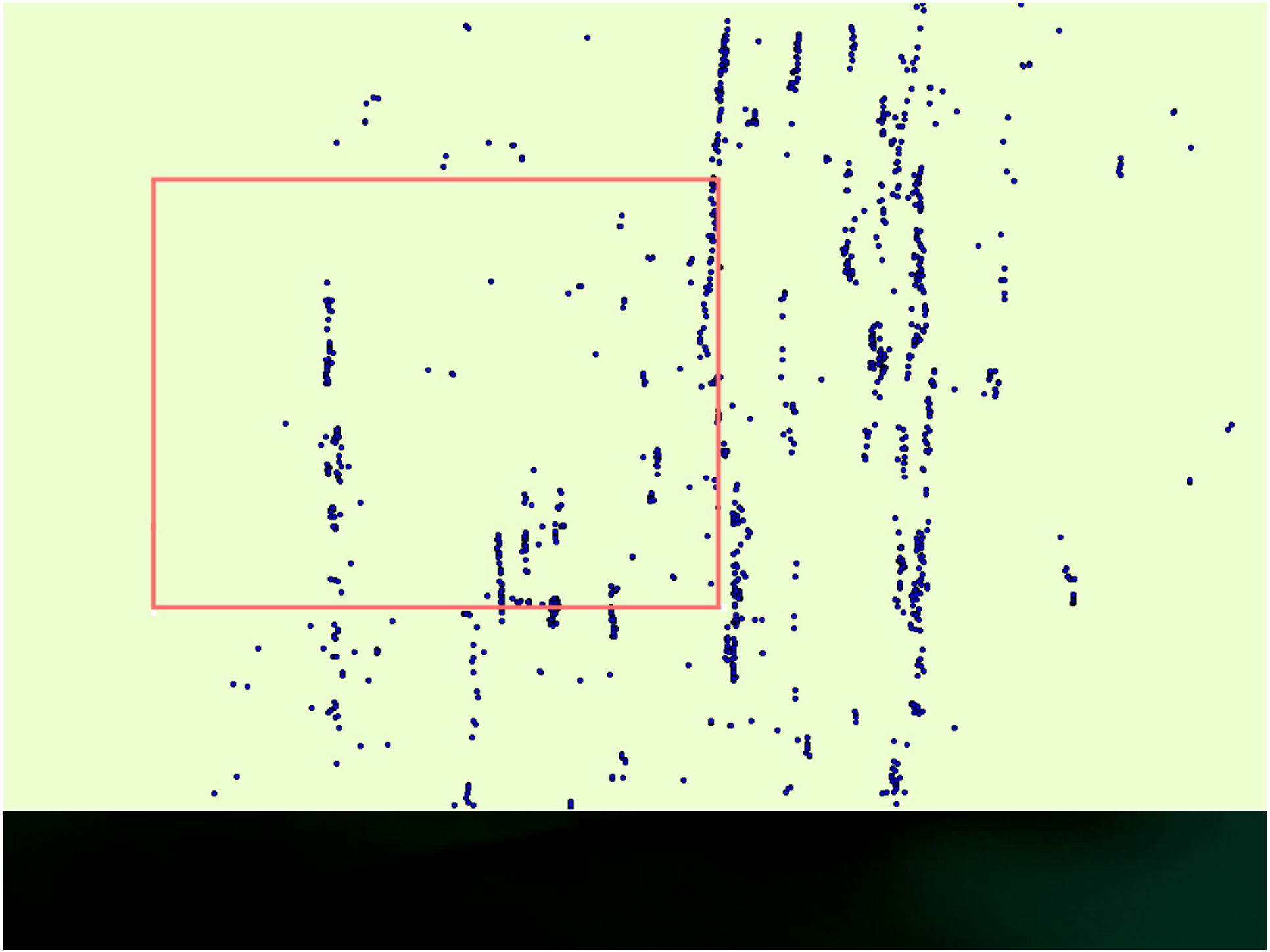


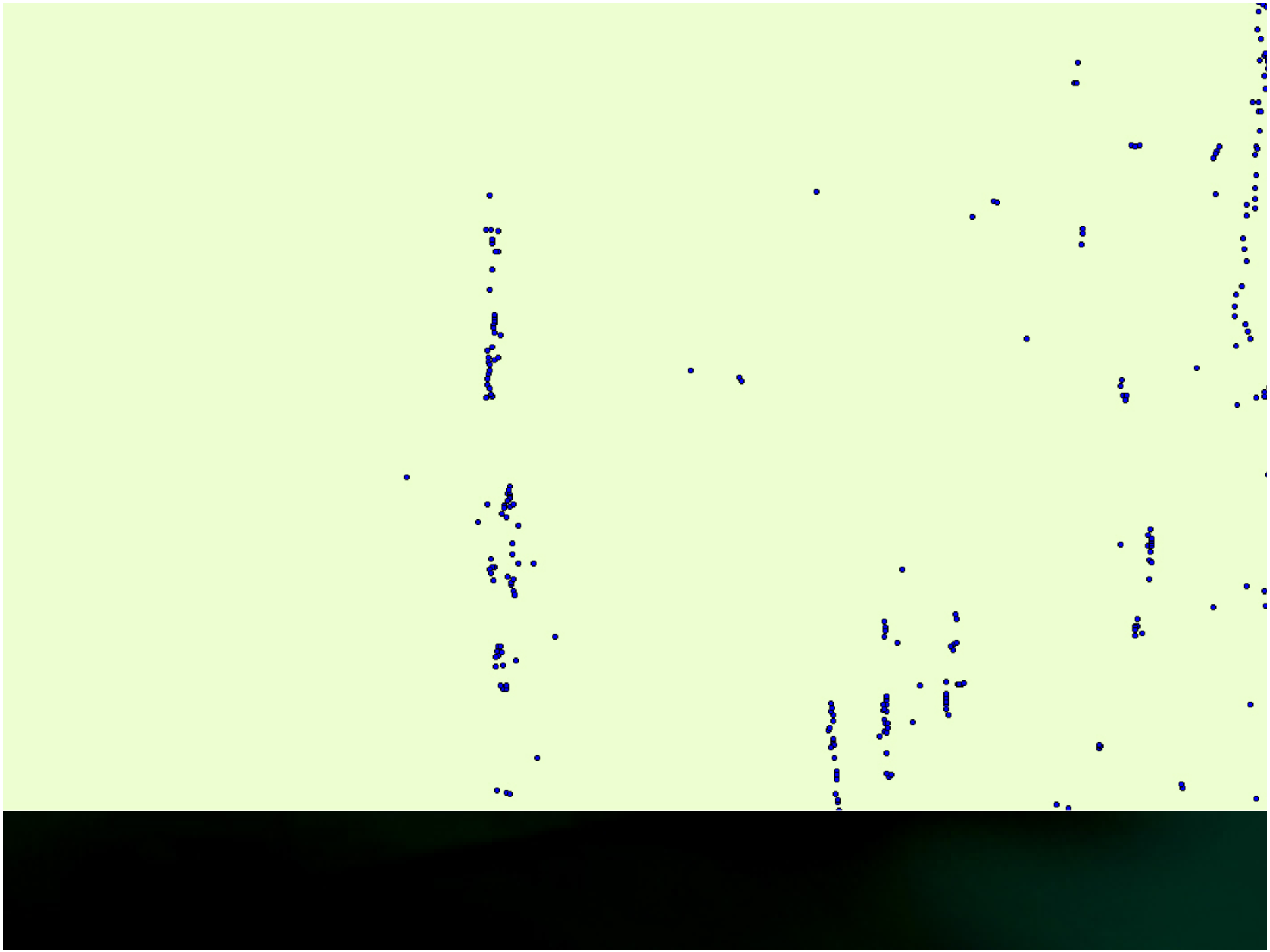


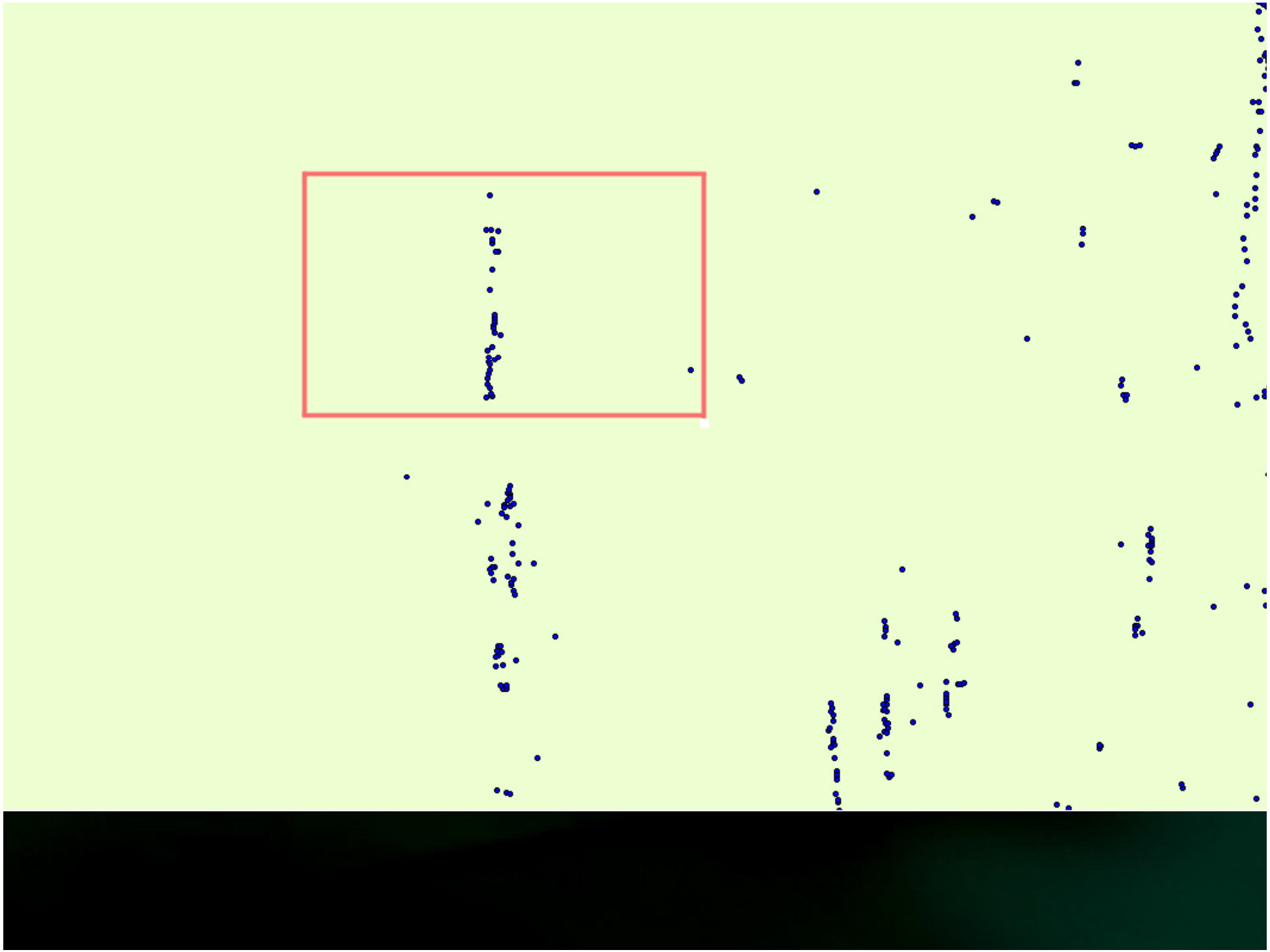


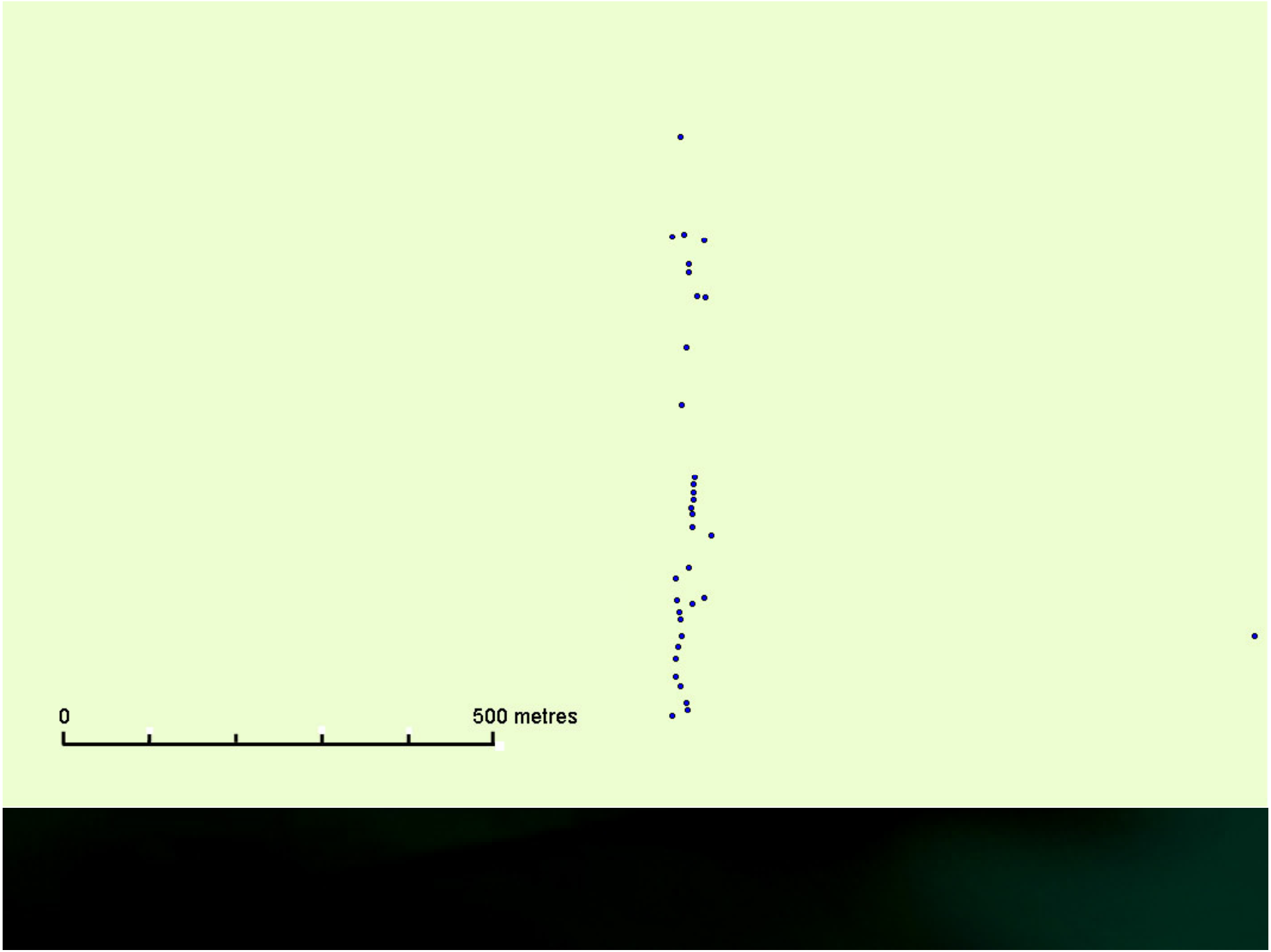











0
500 metres

Pattern Recognition using a Clustering Algorithm

The AUTOCLUST Algorithm

The approach automatically extracts boundaries based on Voronoi modelling and Delaunay Diagrams.

Parameters are not specified by users in the automatic clustering.

All clustering operations takes place on the Delaunay Diagram where data points become vertices and edges connect pairs of points to model spatial proximity.

Estivill-Castro & Lee (2000)[2]

The AUTOCLUST Algorithm

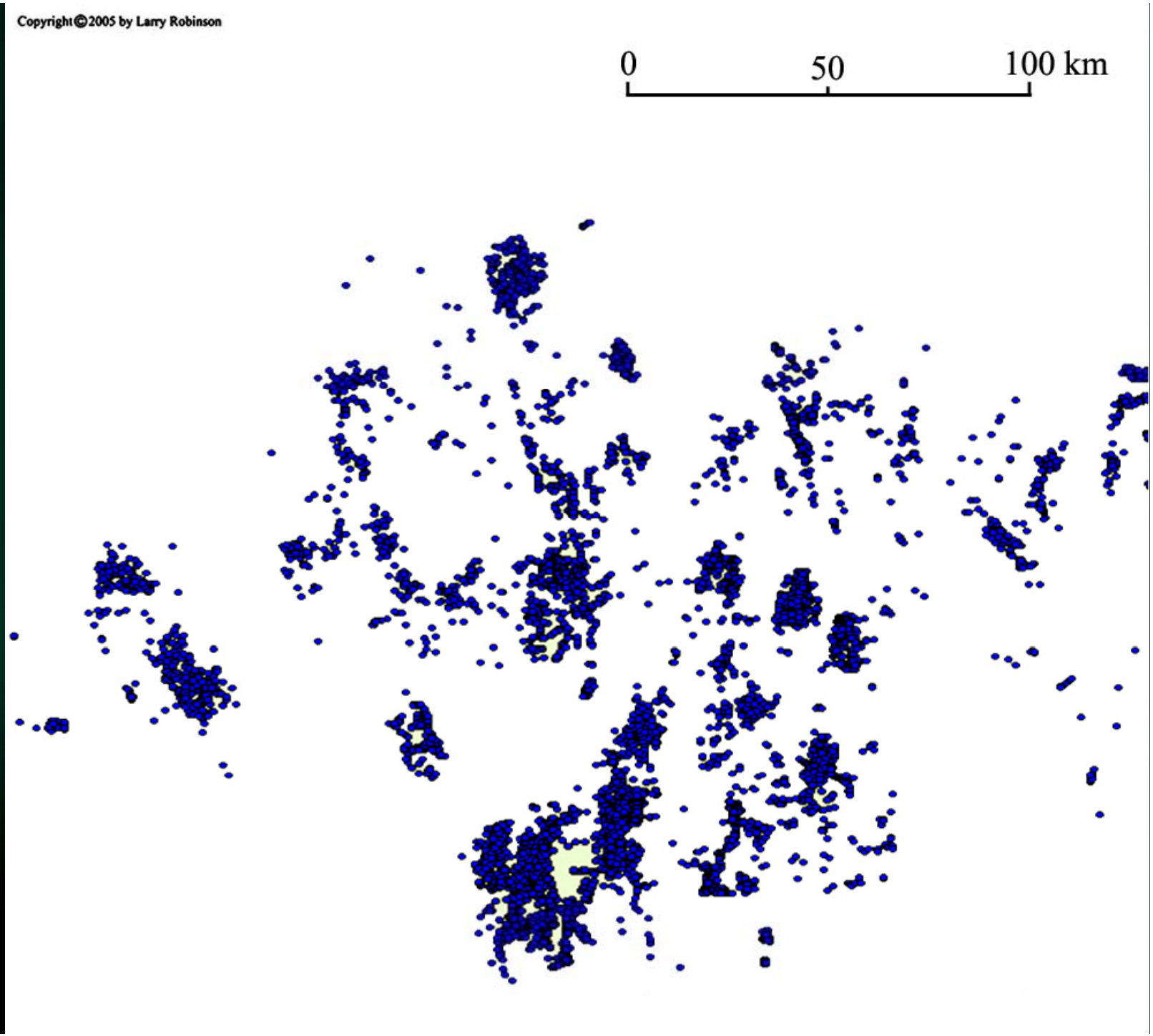
The *m* value shown in the following slides designates the lengths of edges, in units of the standard deviation away from the Global Mean, which are included in a single cluster. The Global Mean is determined from edges in the entire data set.

The *noise index* of a point (p) is the ratio - Local Mean / Global Mean - where, Local Mean is determined from the mean of points with edges incident to that point (p). The *noise index* is a measure of the deviation of any single point from proximal points. The mean of edges incident to noise tends to be significantly greater than the Global Mean.

The *m* value can be used as an exploration tool.

- Larger values of *m* causes relatively close clusters to merge into the same cluster.
- Smaller values of *m* result in clusters with more homogeneous lengths of edges.
- Smaller values of *m* identifies relatively high-density clusters and homogeneous clusters, but declares relatively sparse clusters as noise and heterogeneous clusters as potential outliers.
- The user may reduce the value of *m* to find breakable or vulnerable regions in clusters where they are about to split.

The gold deposits that were clustered in the Bendigo-Ballarat Region

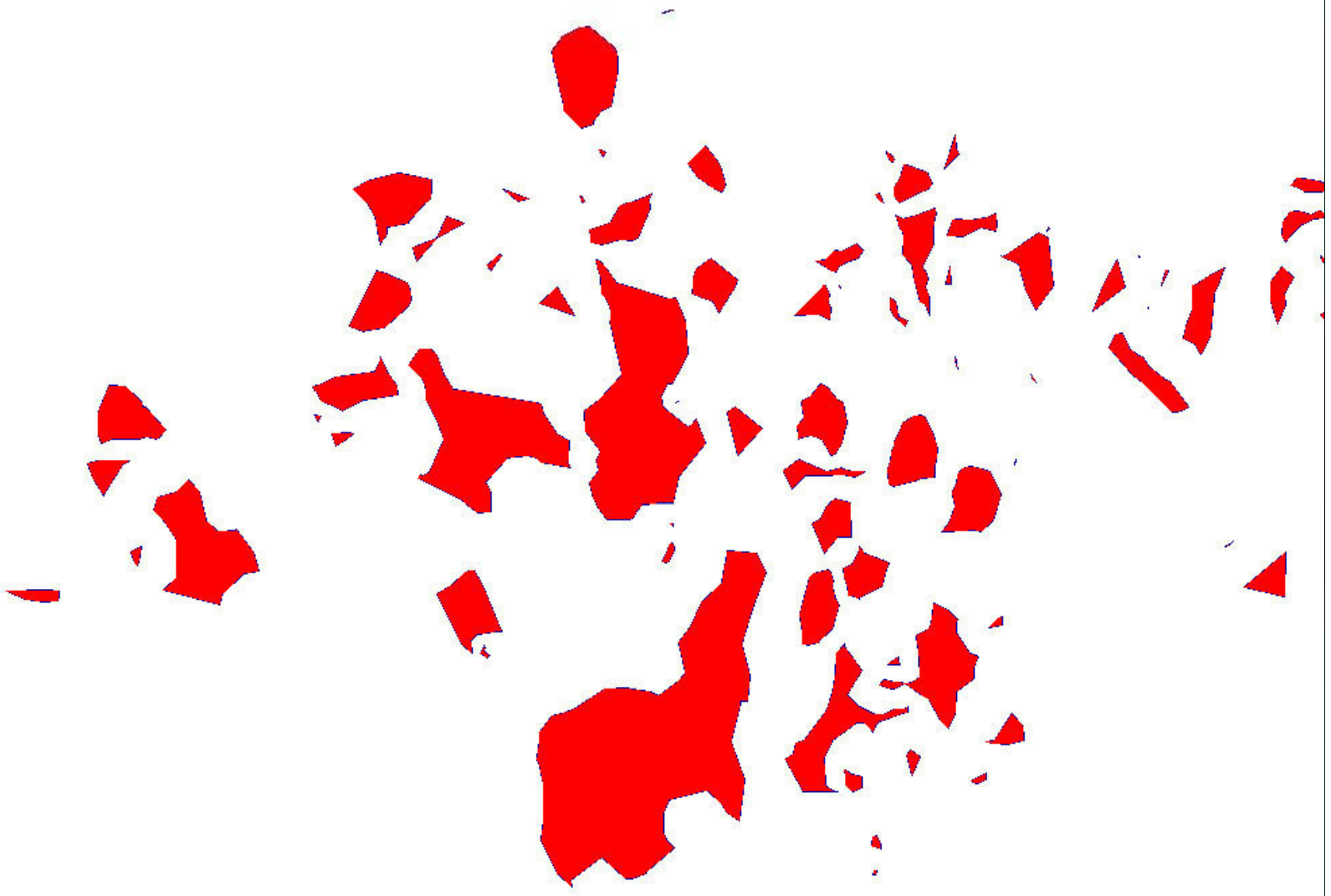


Implementing the AUTOCLUST Algorithm

The following images show Polygonization of gold deposits in the Bendigo-Ballarat region at various *m* values with 0% noise.

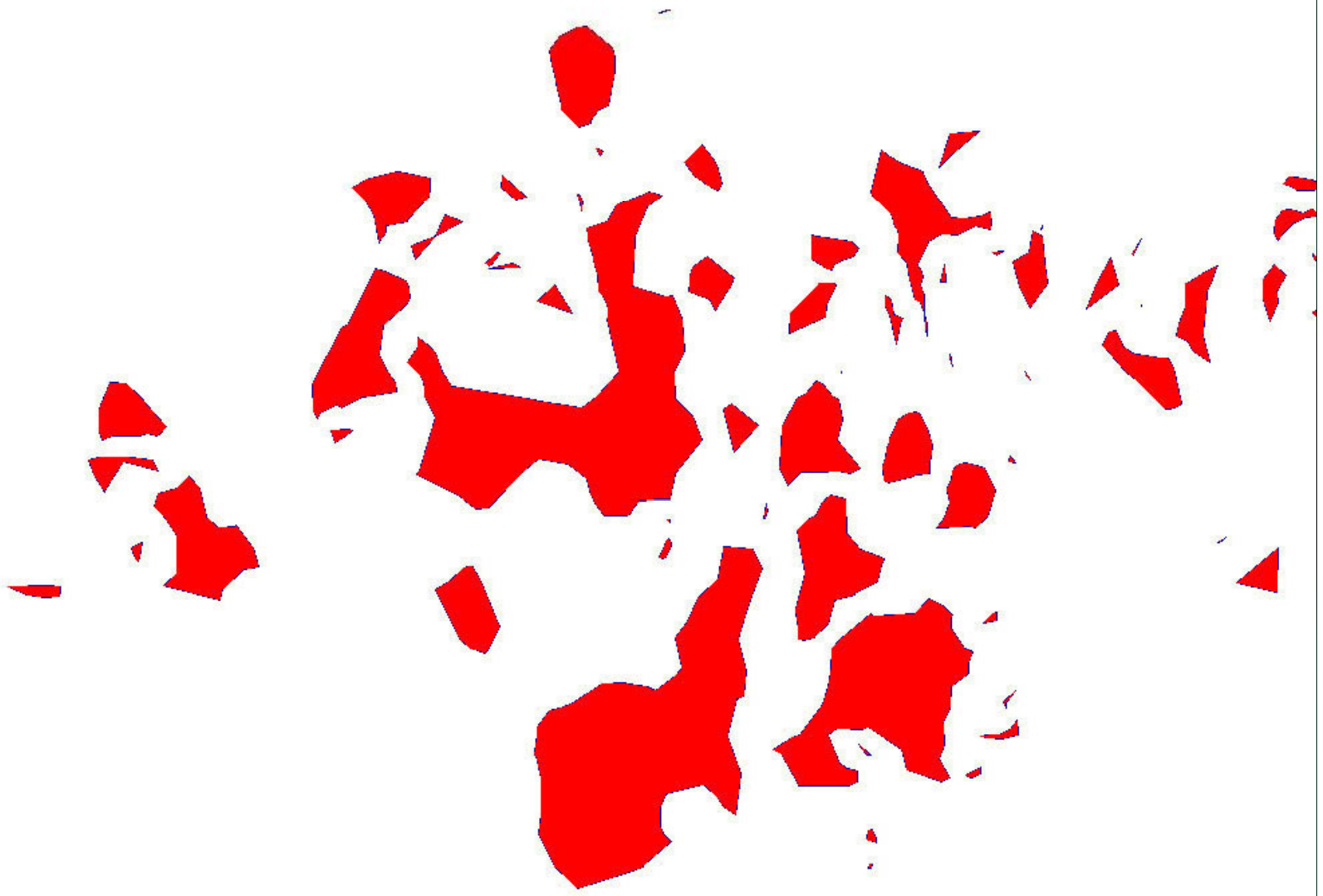
These images progress at a predetermined timing from $m = 0.8$ to $m = 4.0$.

$m = 0.8$



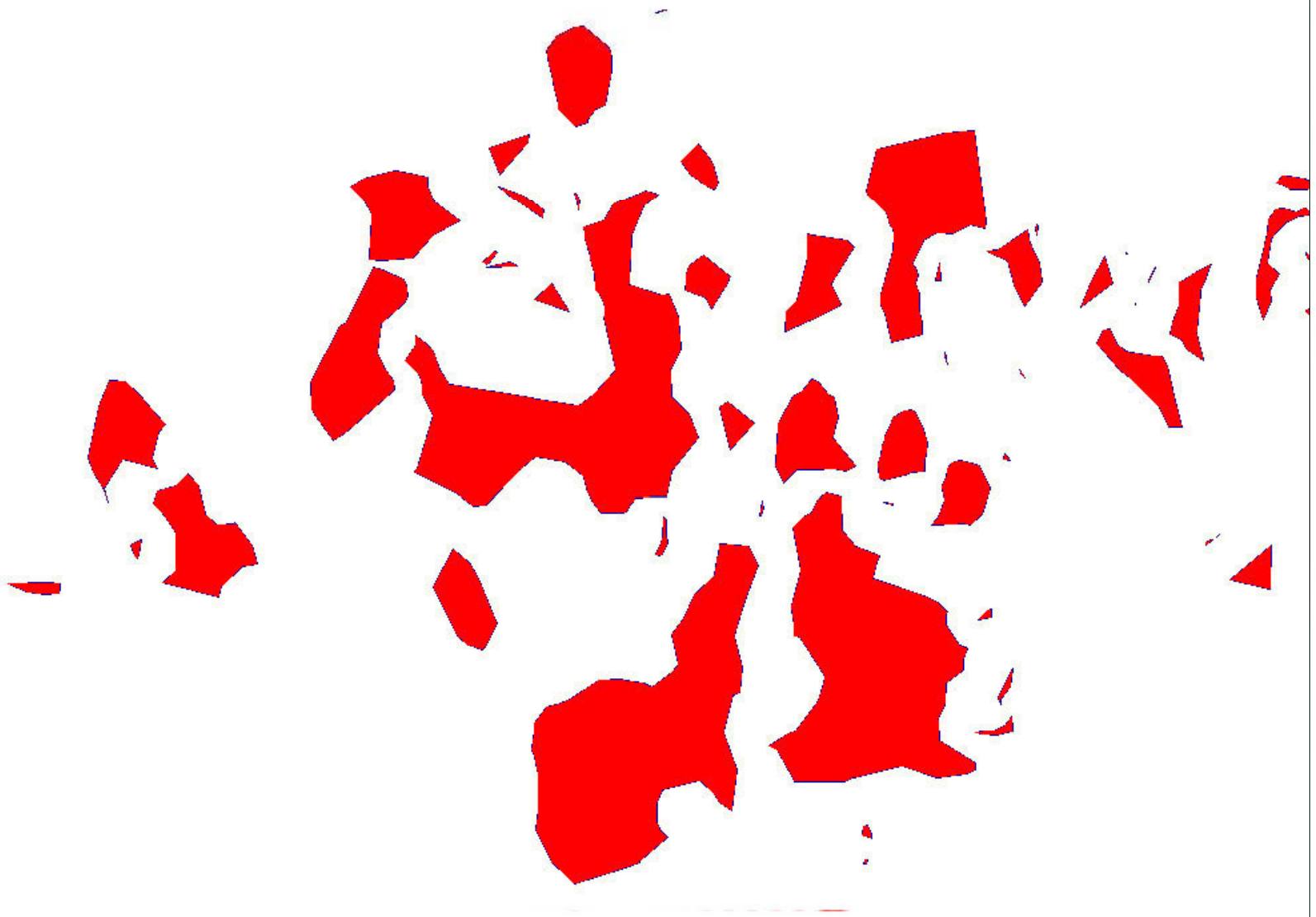
$m = 0.9$

$m = 1.0$

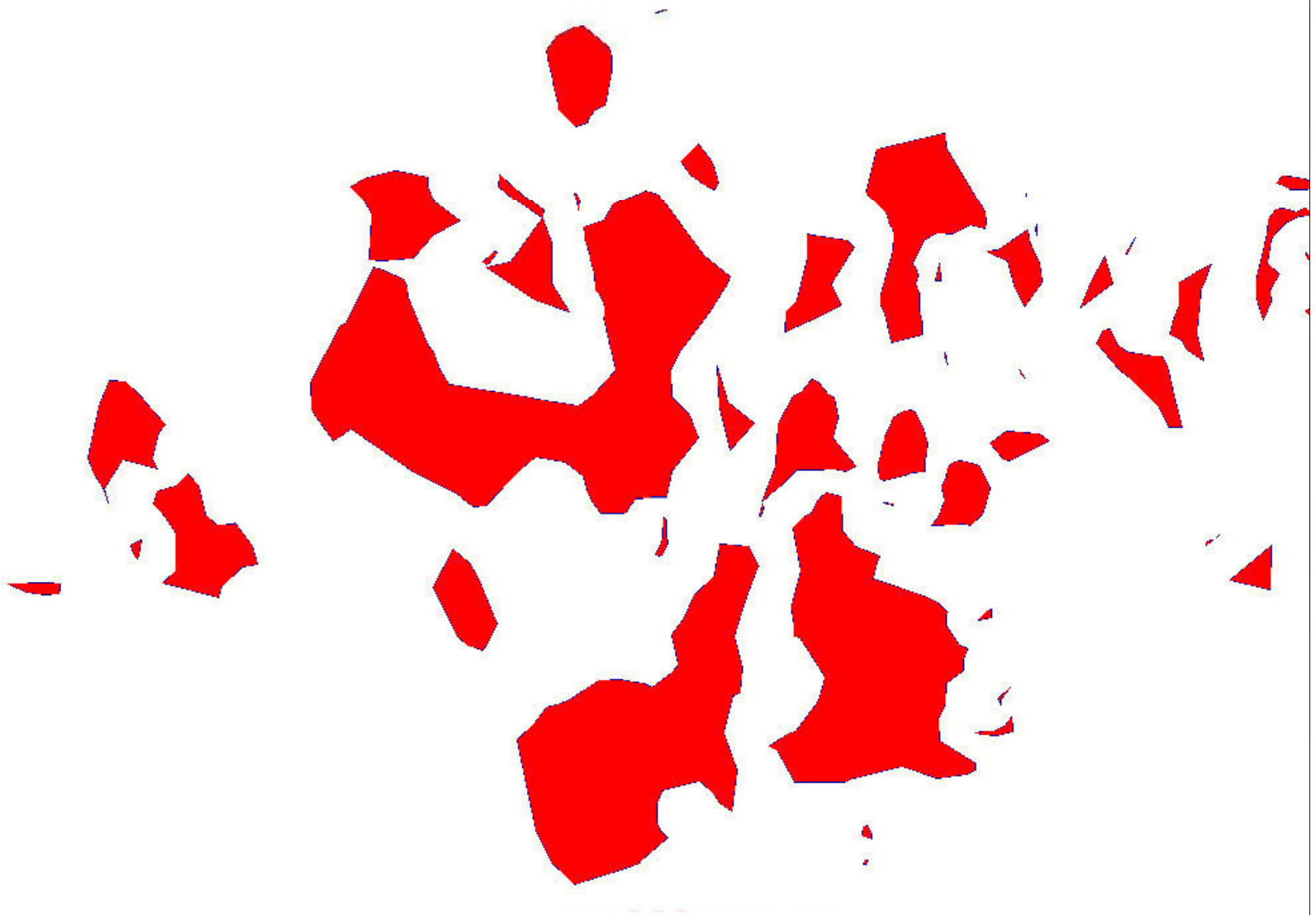


$m = 1.1$

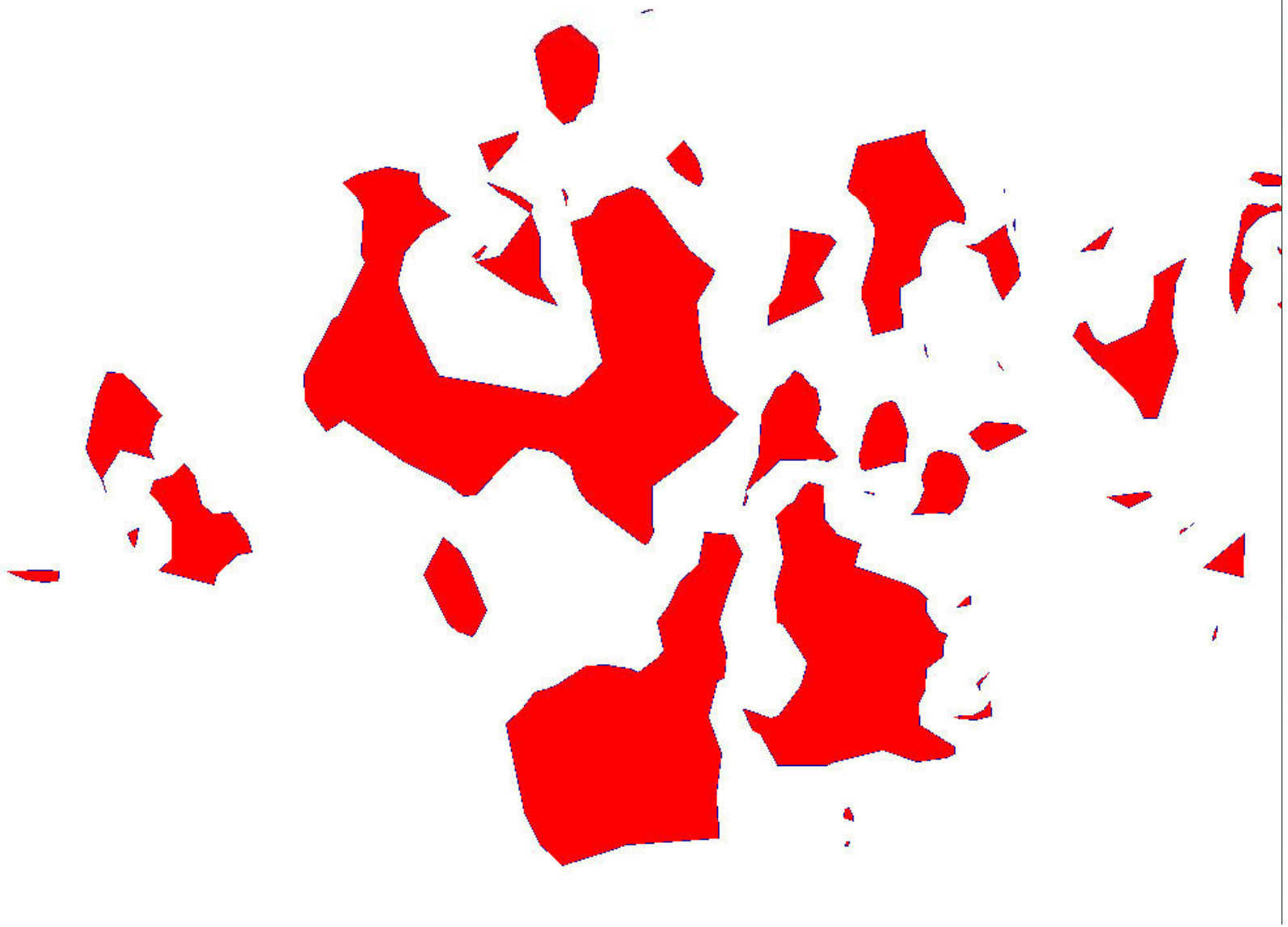
$m = 1.2$



$m = 1.3$



$m = 1.4$

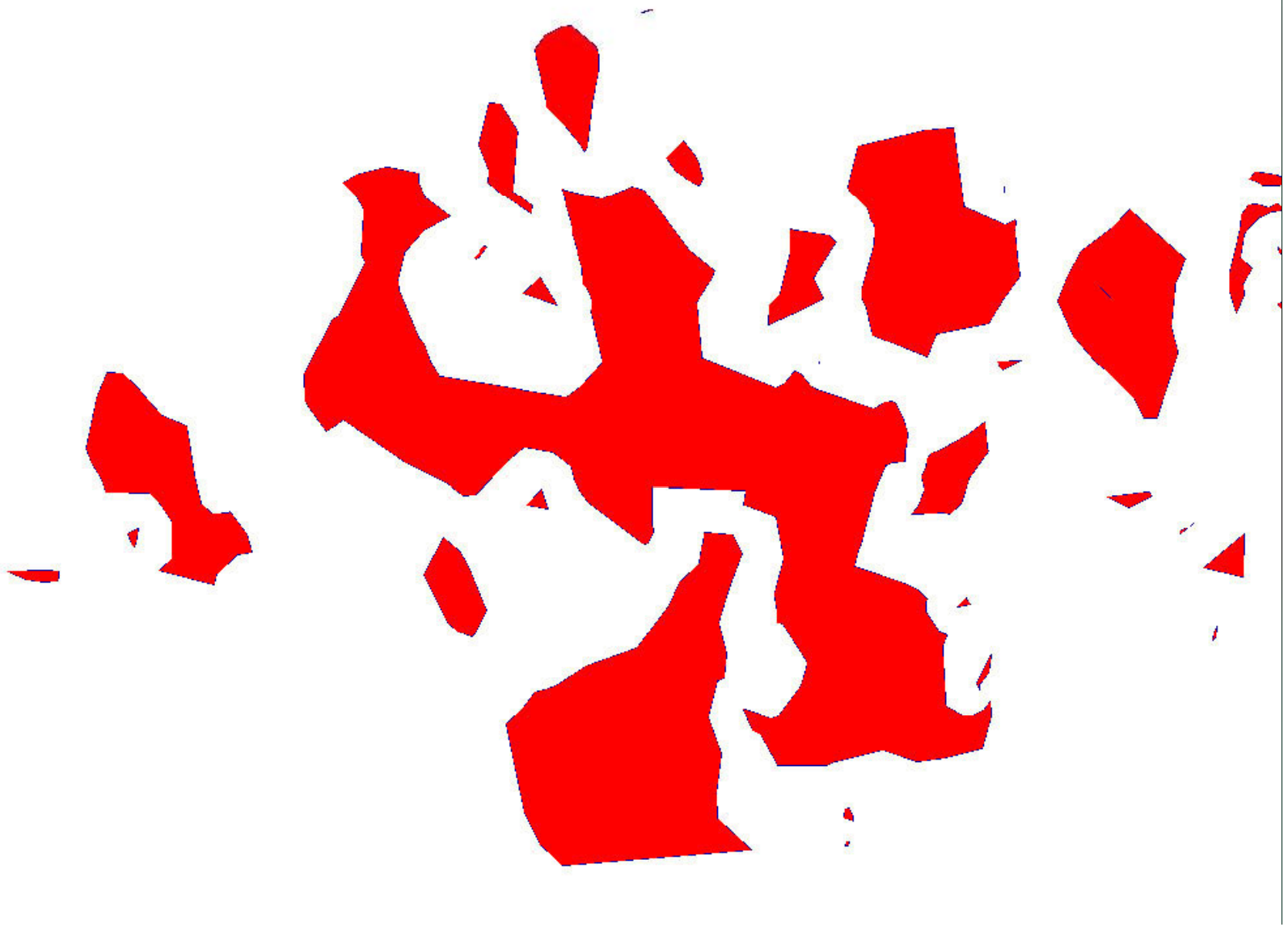


$m = 1.5$

$m = 1.6$

$m = 1.7$

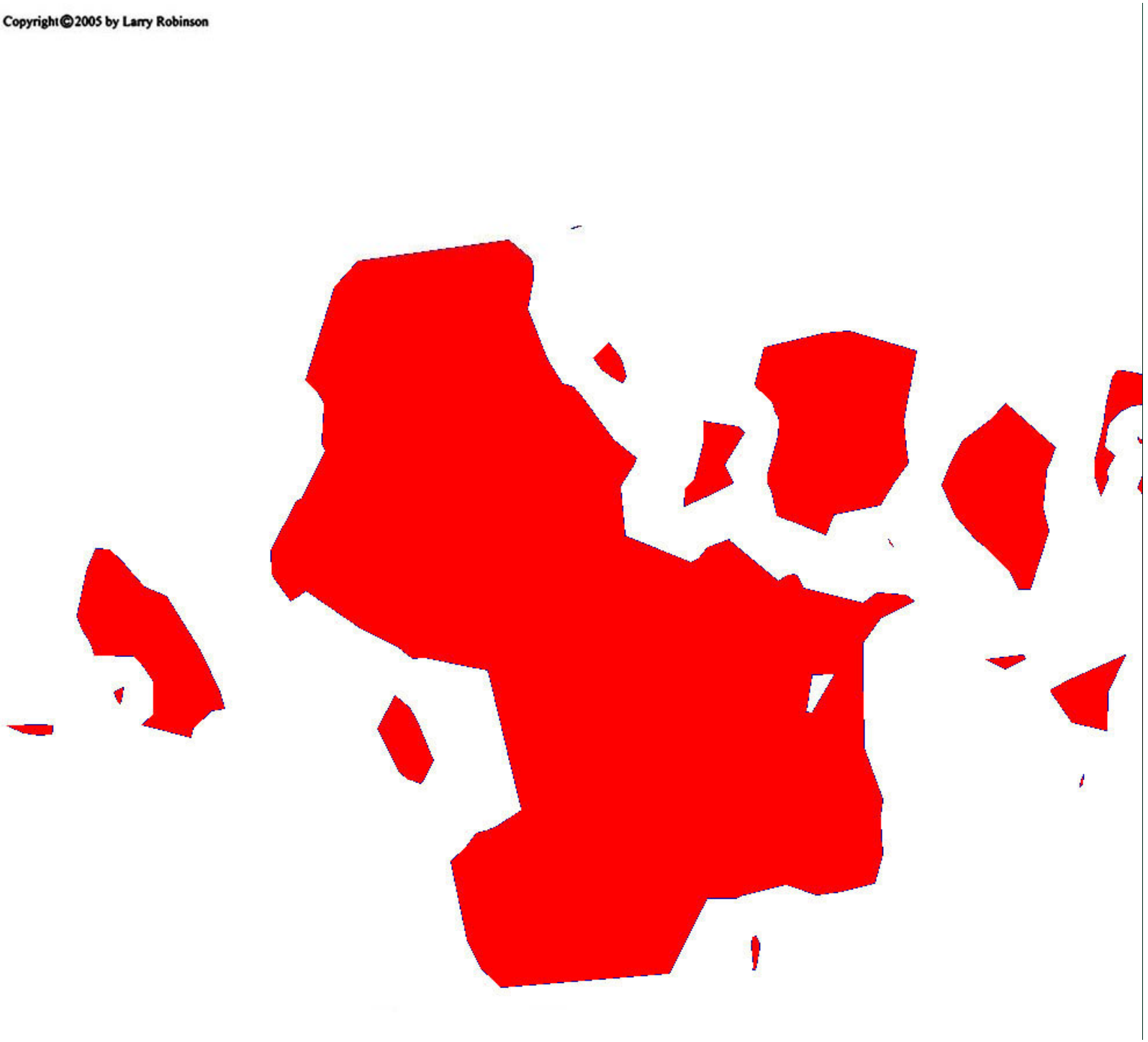
$m = 1.8$



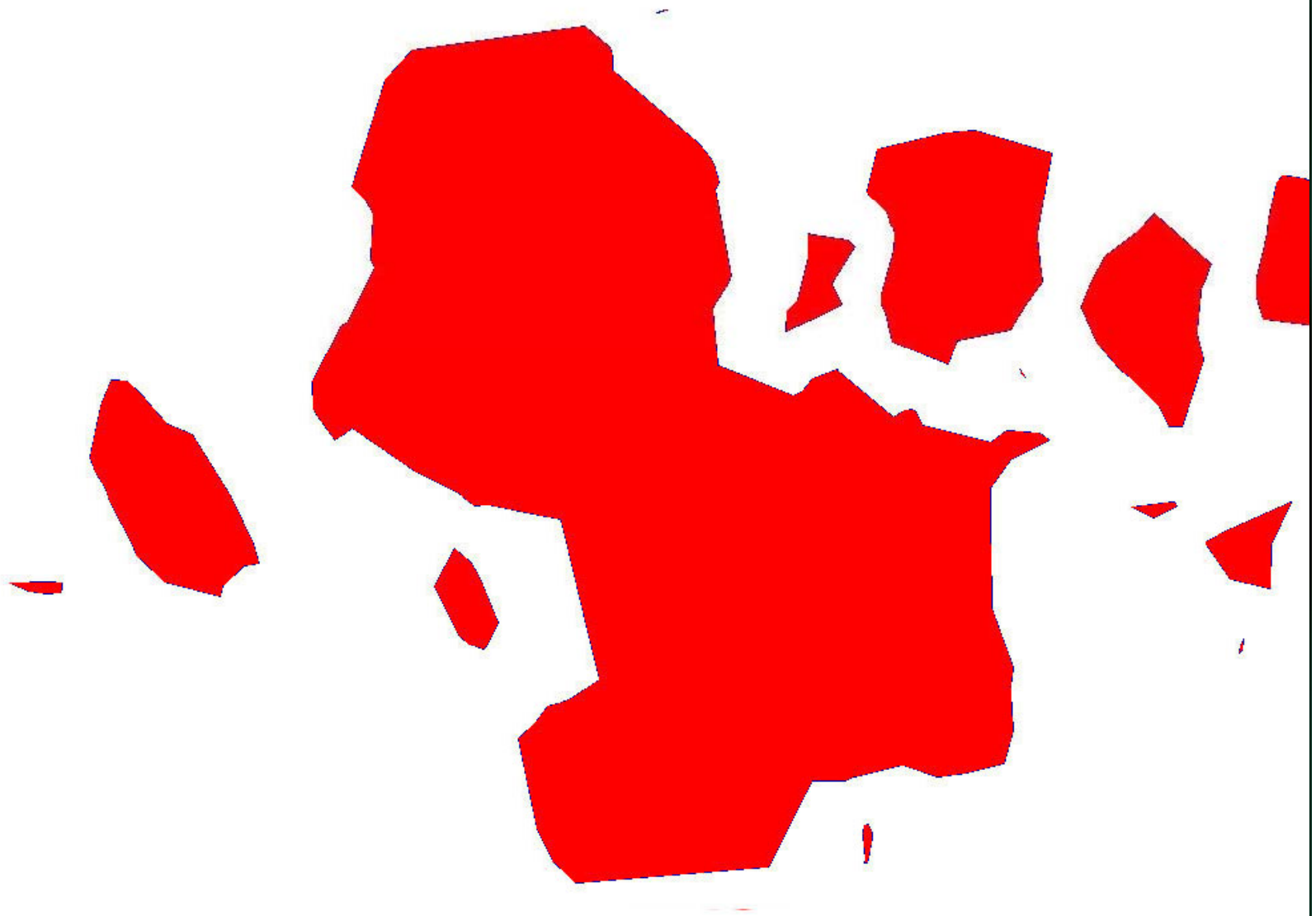
$m = 1.9$

$m = 2.0$

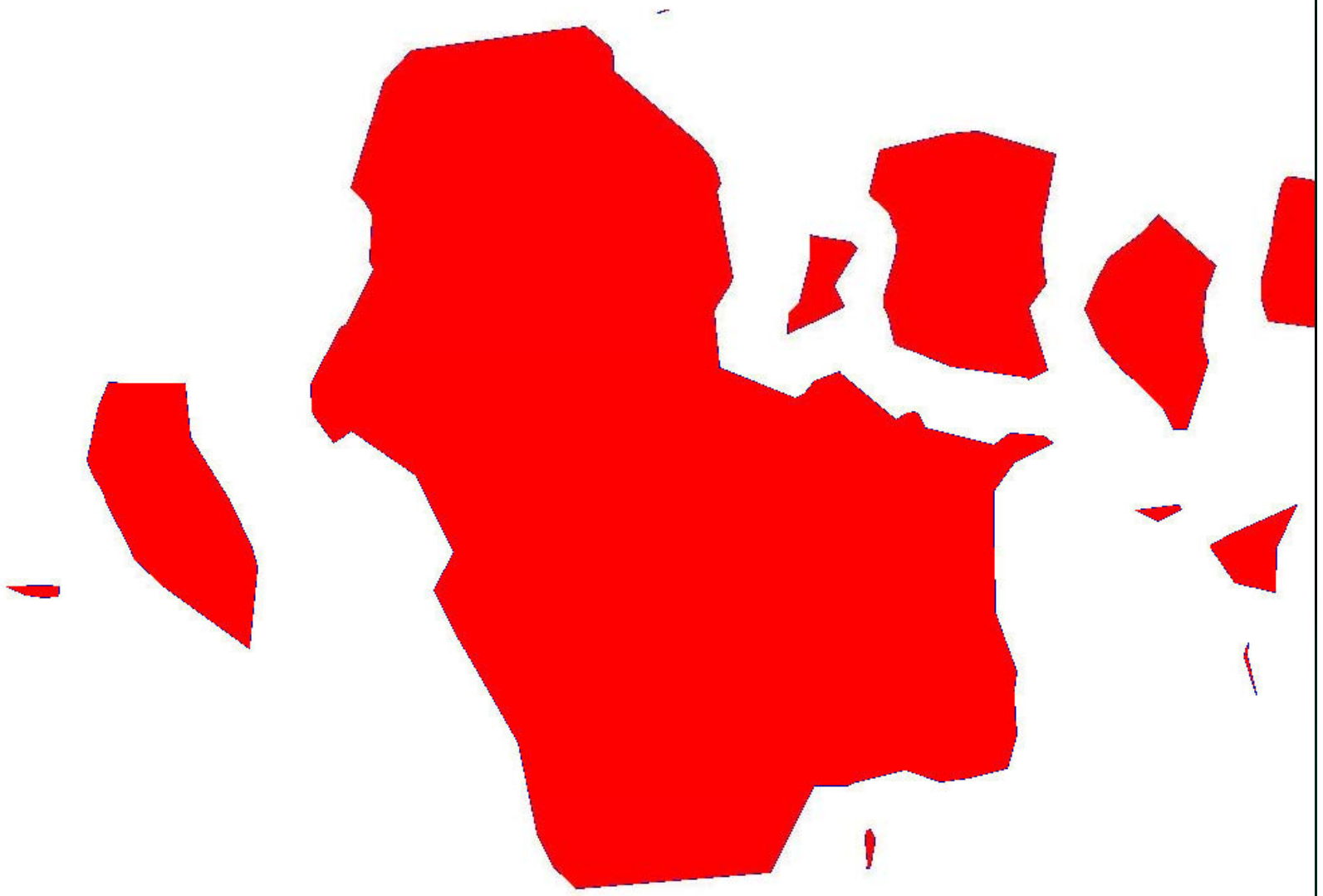
$m = 2.5$



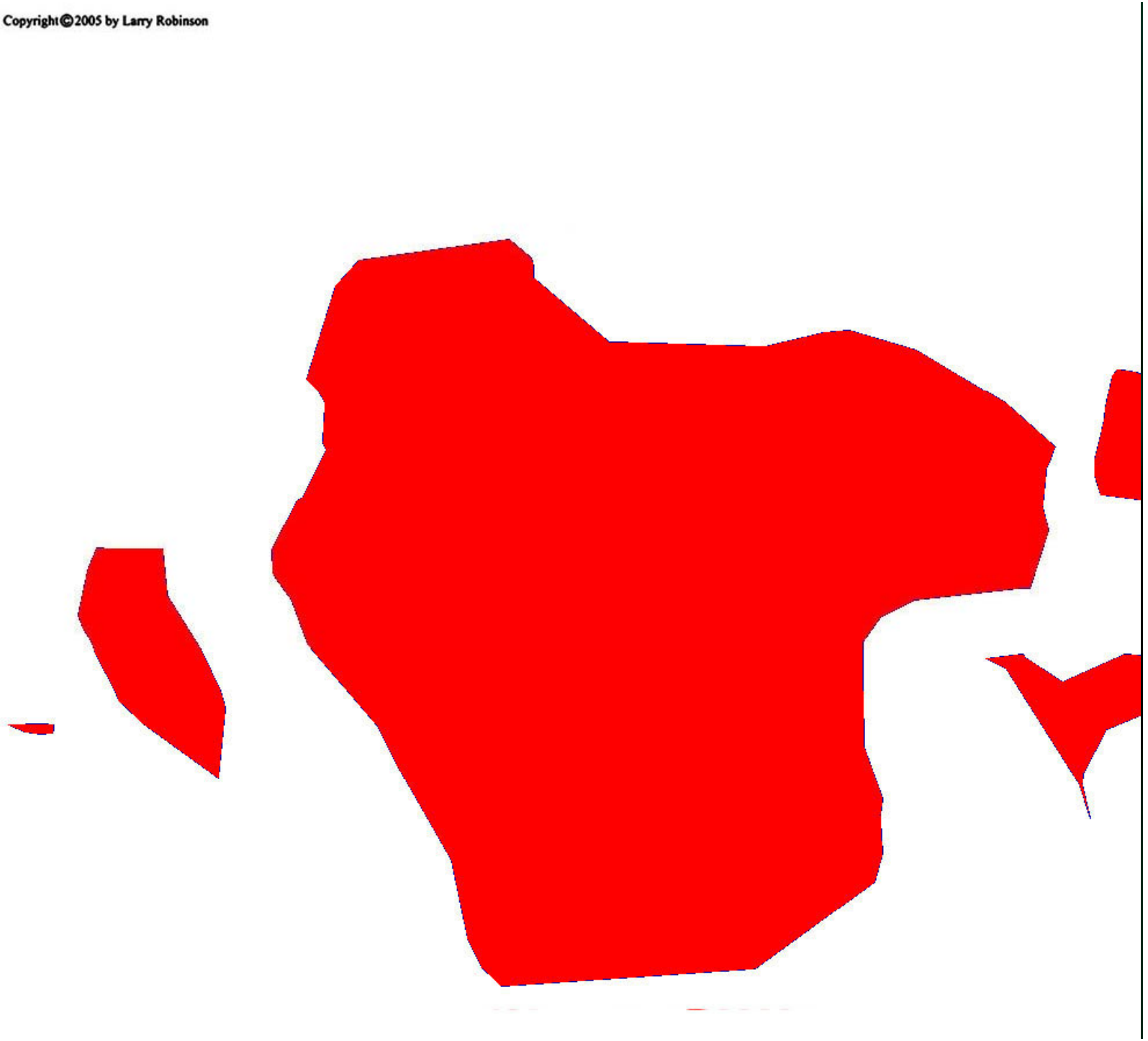
$m = 3.0$



$m = 3.5$



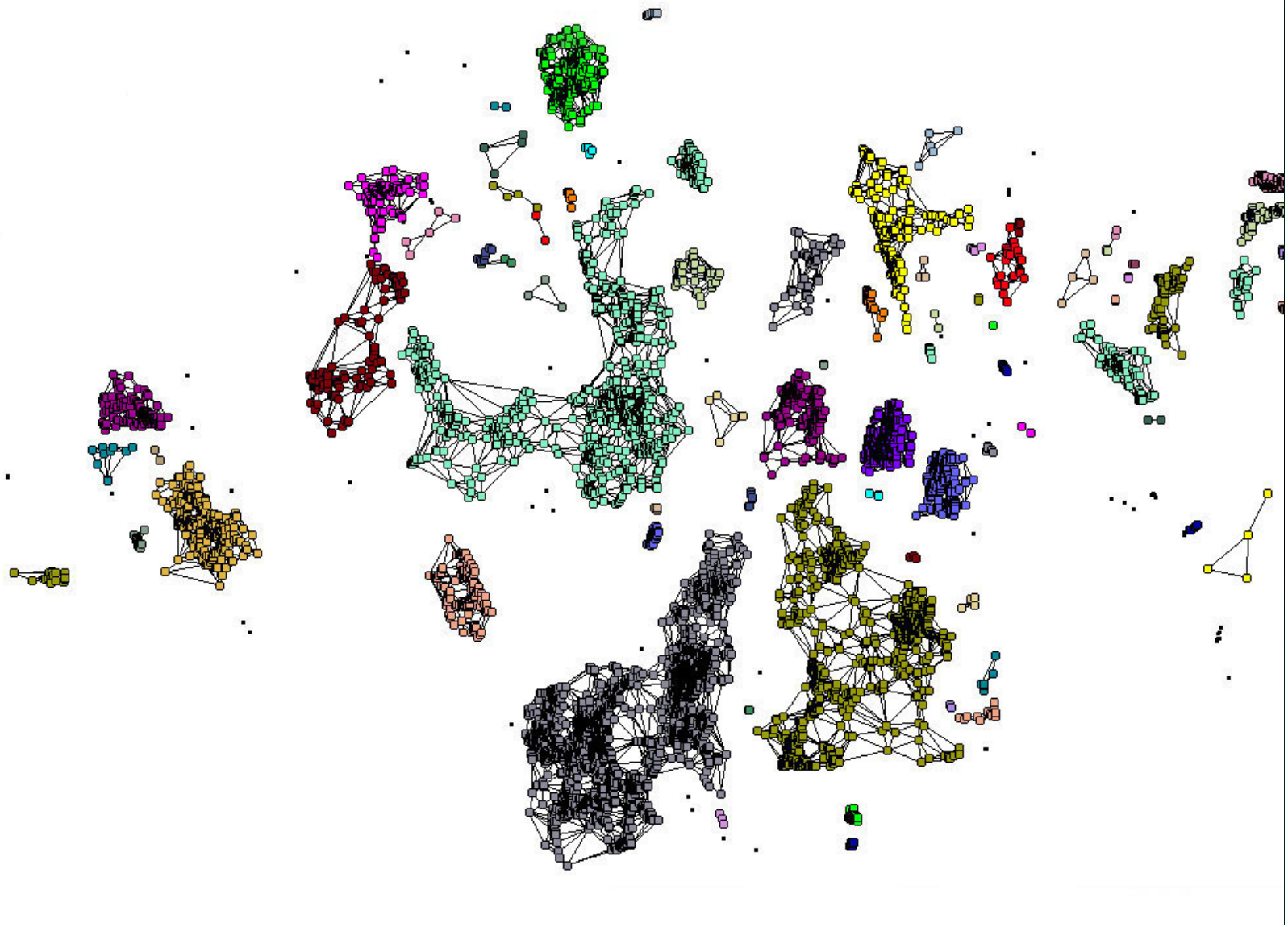
$m = 4.0$



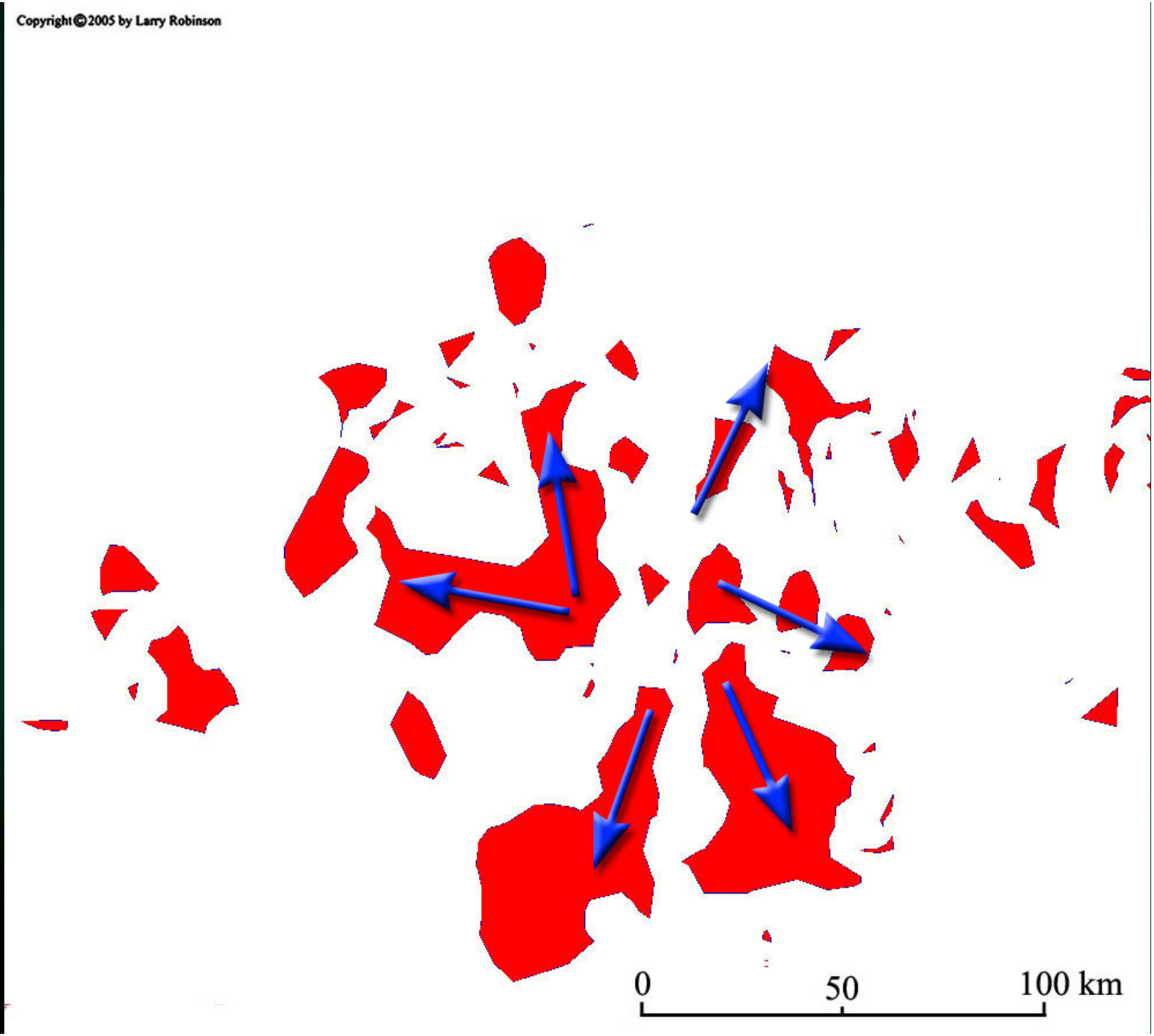
Using the AUTOCLUST algorithm there is an optimum *m* value for clustering, after which information is actually lost.

The optimum clustering for the Bendigo-Ballarat region is *m* = 1.1.

Clustering
$m = 1.1$



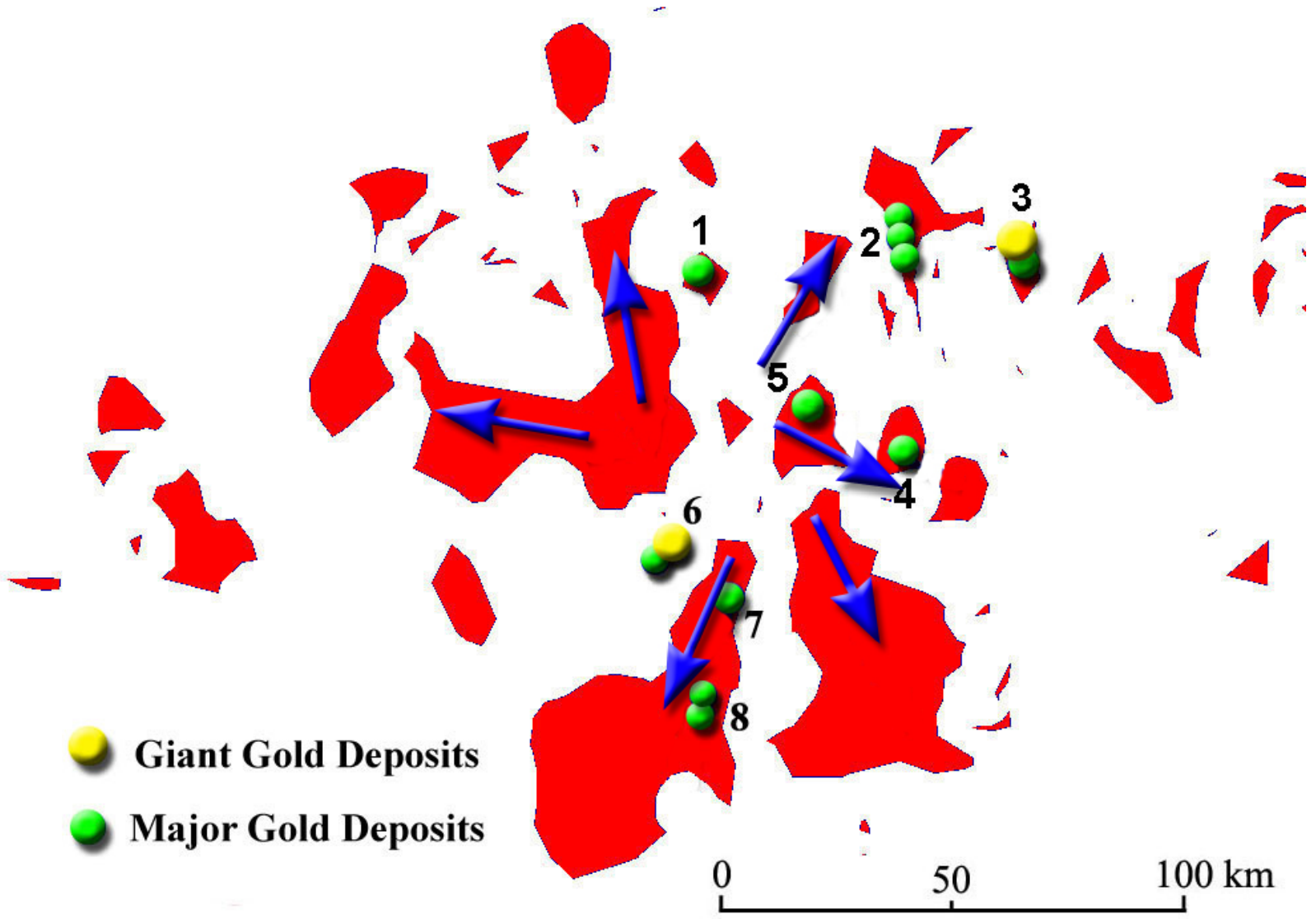
Polygonization with radial trends for *m* = 1.1



Note that there are NO gold deposits at the very centre of the radial pattern.

This is a characteristic of many, if not most, of the ~80 km diameter clusters in southeastern Australia.

The Giant and Major Gold Deposits[3]



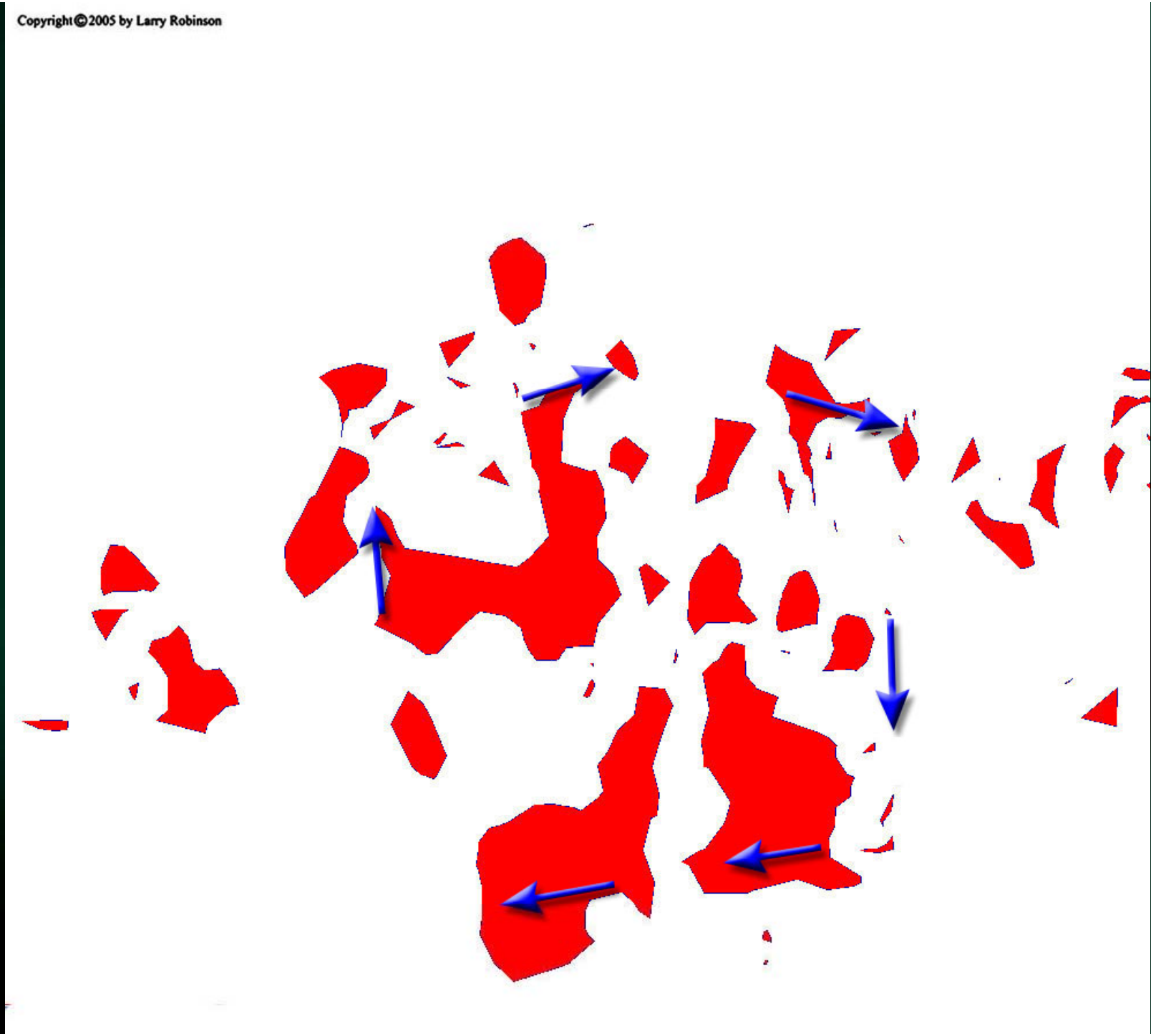
Generally the giant and major gold deposits in southeastern Australia occur proximal to the empty centre, with the small deposits occurring primarily in the radial zones.

However, for the Bendigo-Ballarat region this appears not to be the case.

The explanation may be in the very shape of the radial patterns in this region.

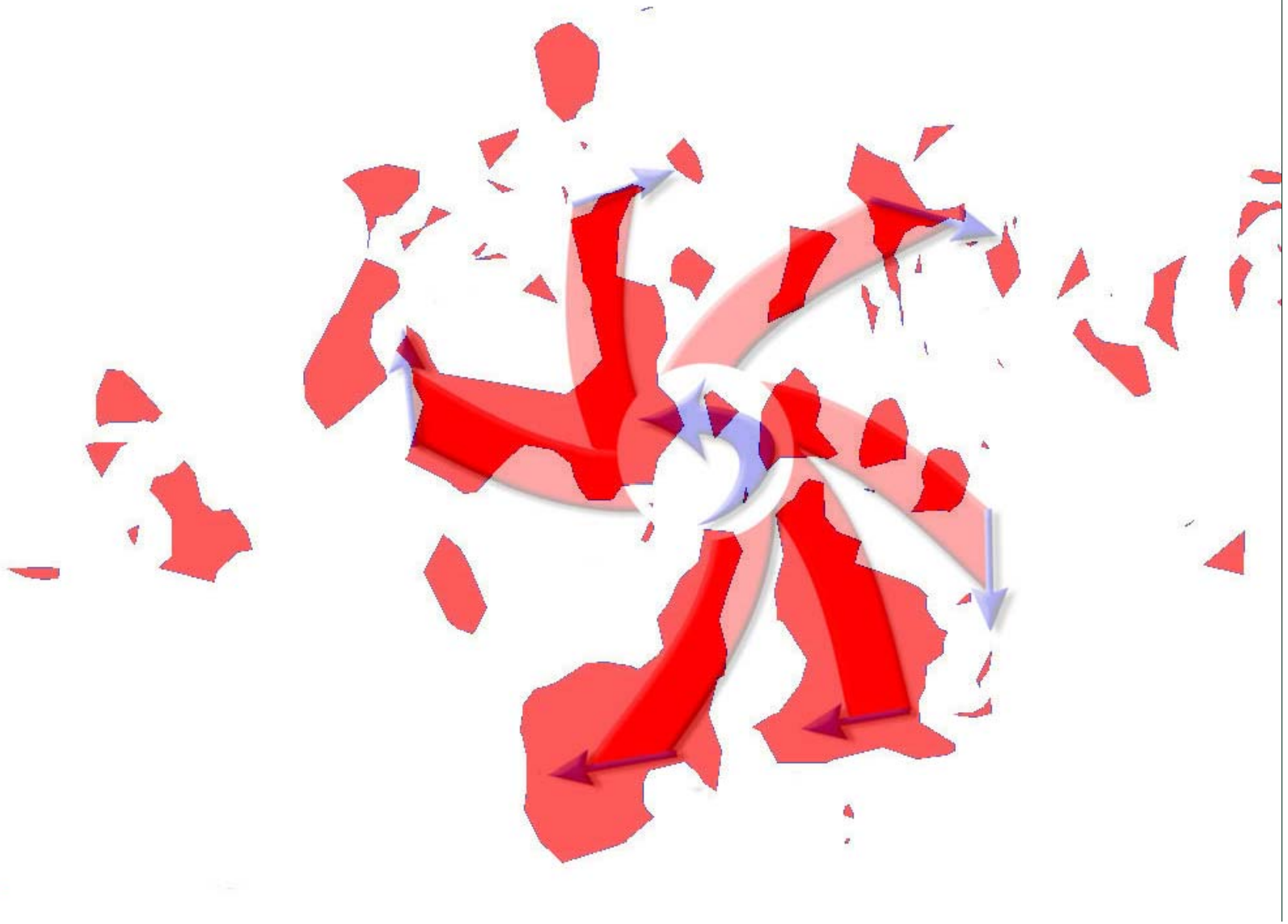
The tails on the ends of each radial zone indicate that the entire pattern was rotating at the time of gold deposition.

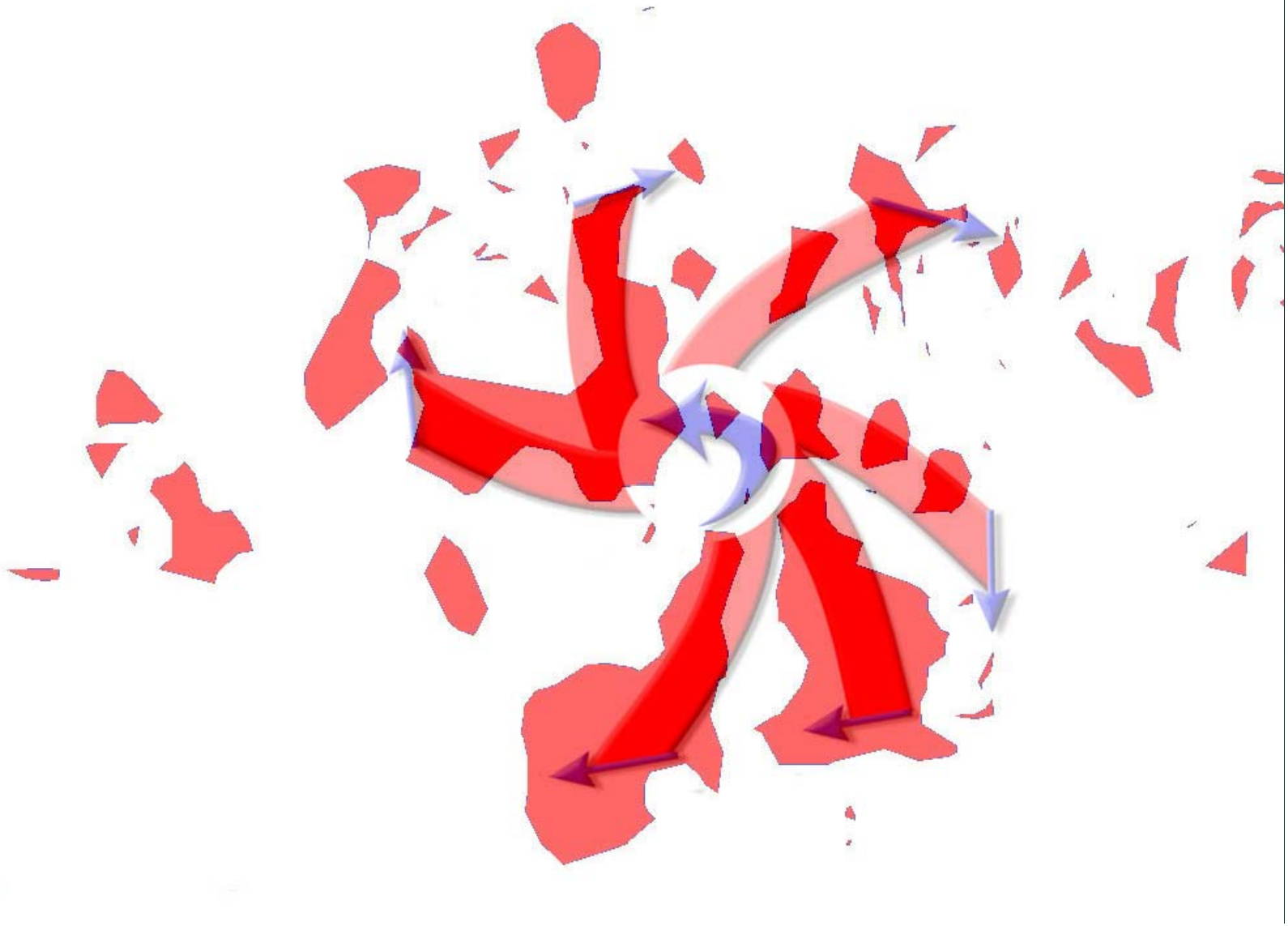
Rotation may have created unique deposition sites to circulating hydrothermal fluids.

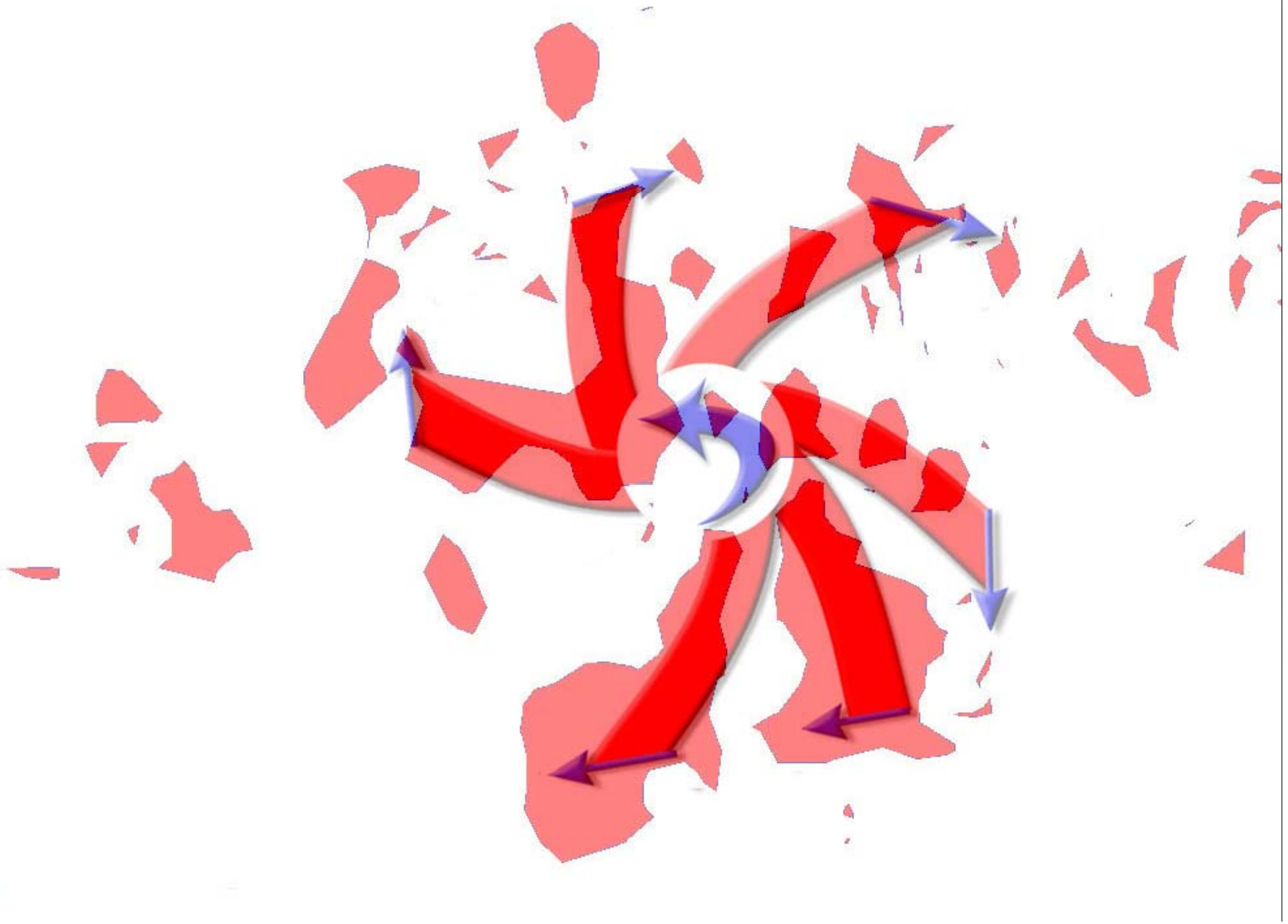


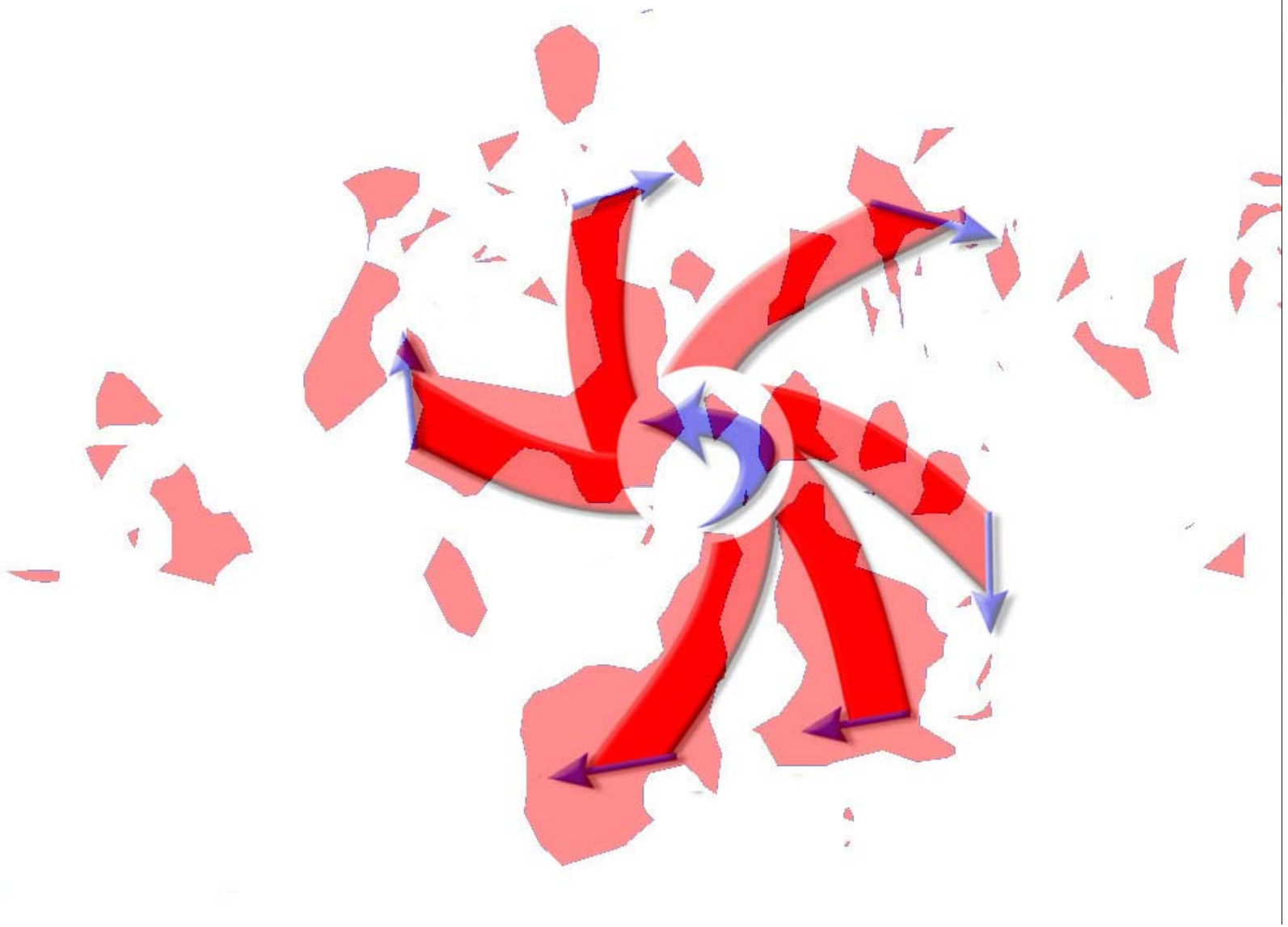
Both Meyerhoff[5] and O'Driscoll[6] suggest that vortices, similar to those seen in the Earth's atmosphere, can exist in the mantle.

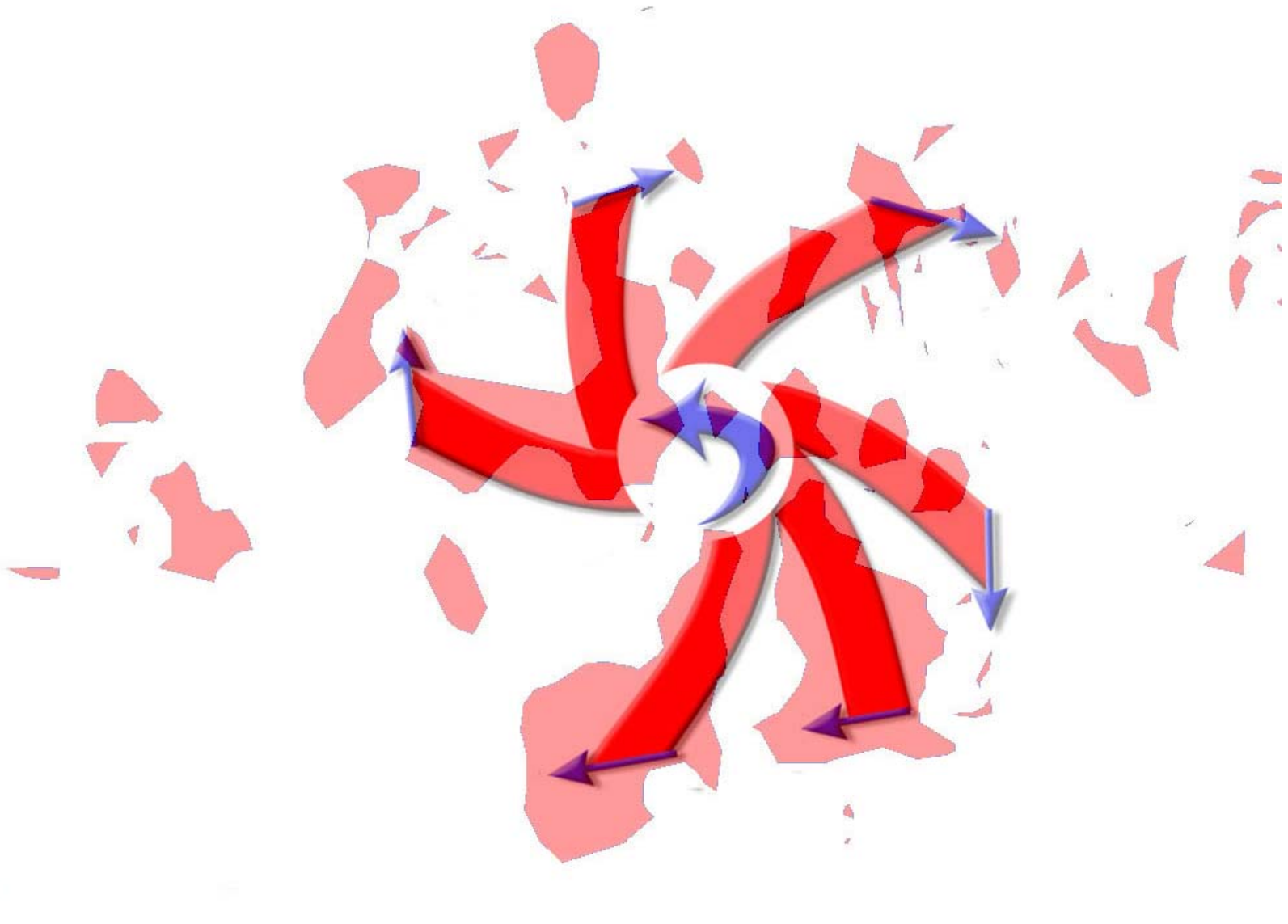
The following timed sequences shows, diagrammatically, the proposed anticlockwise rotation created by Earth Tide forces for the southern hemisphere[7, 8].

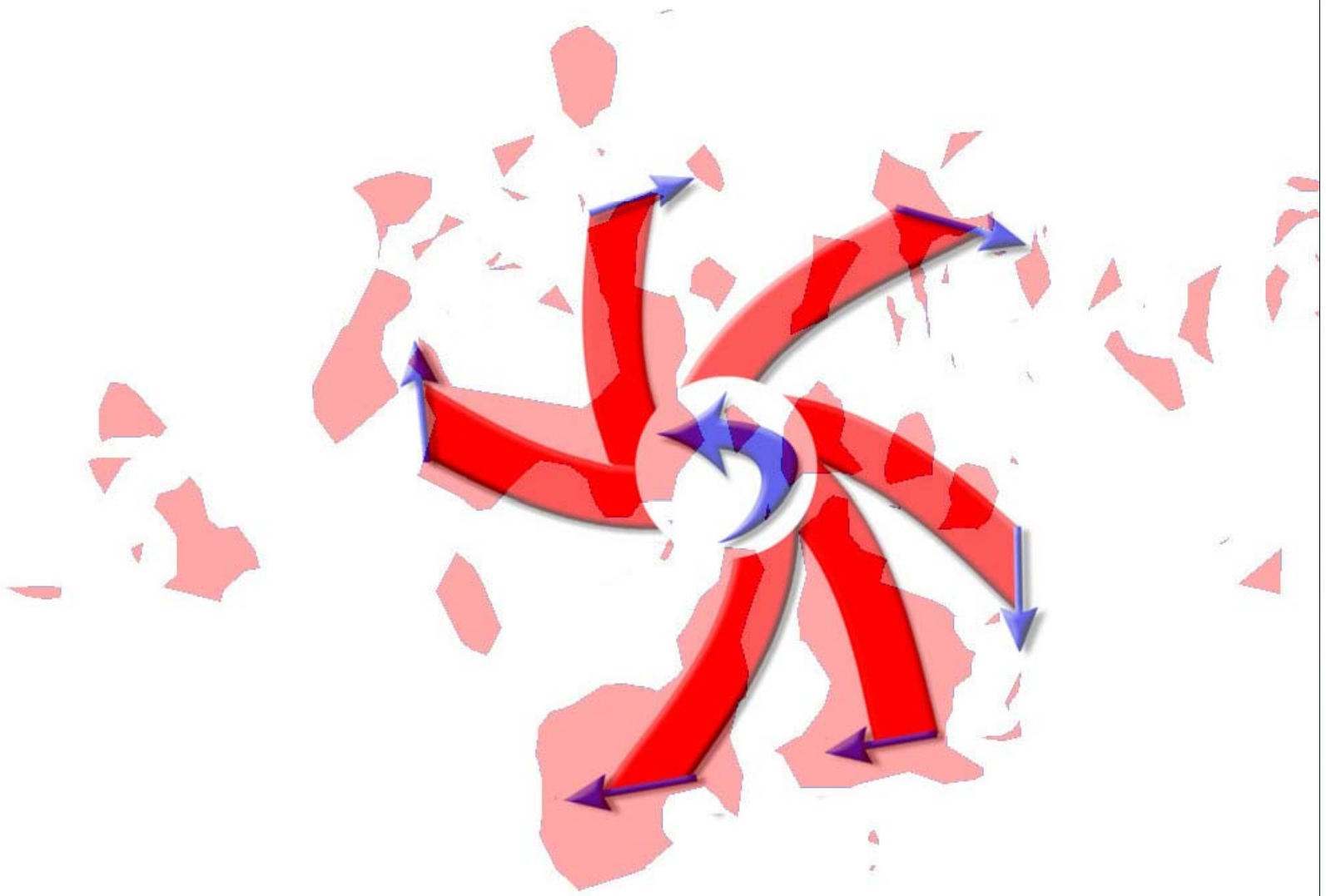


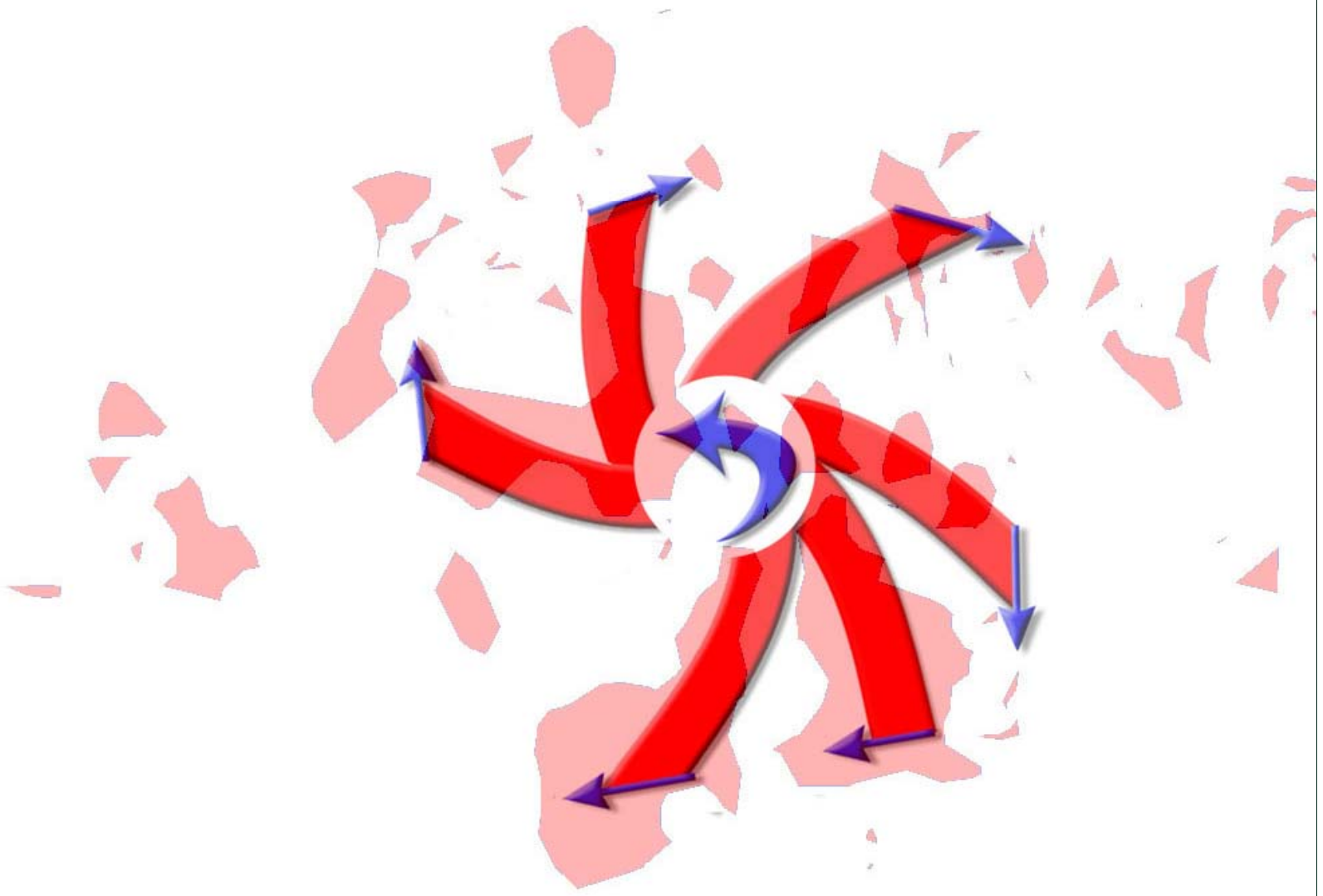


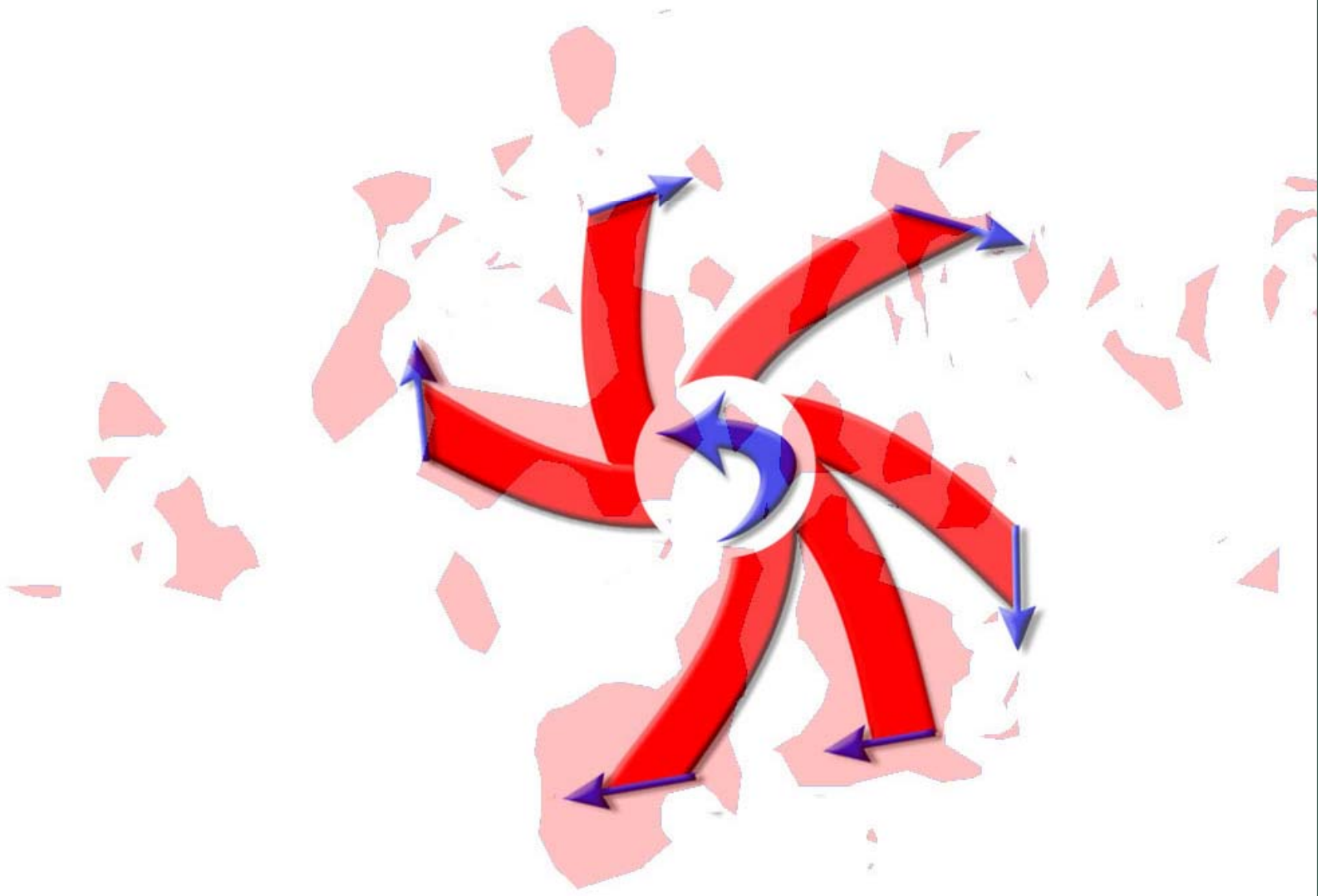


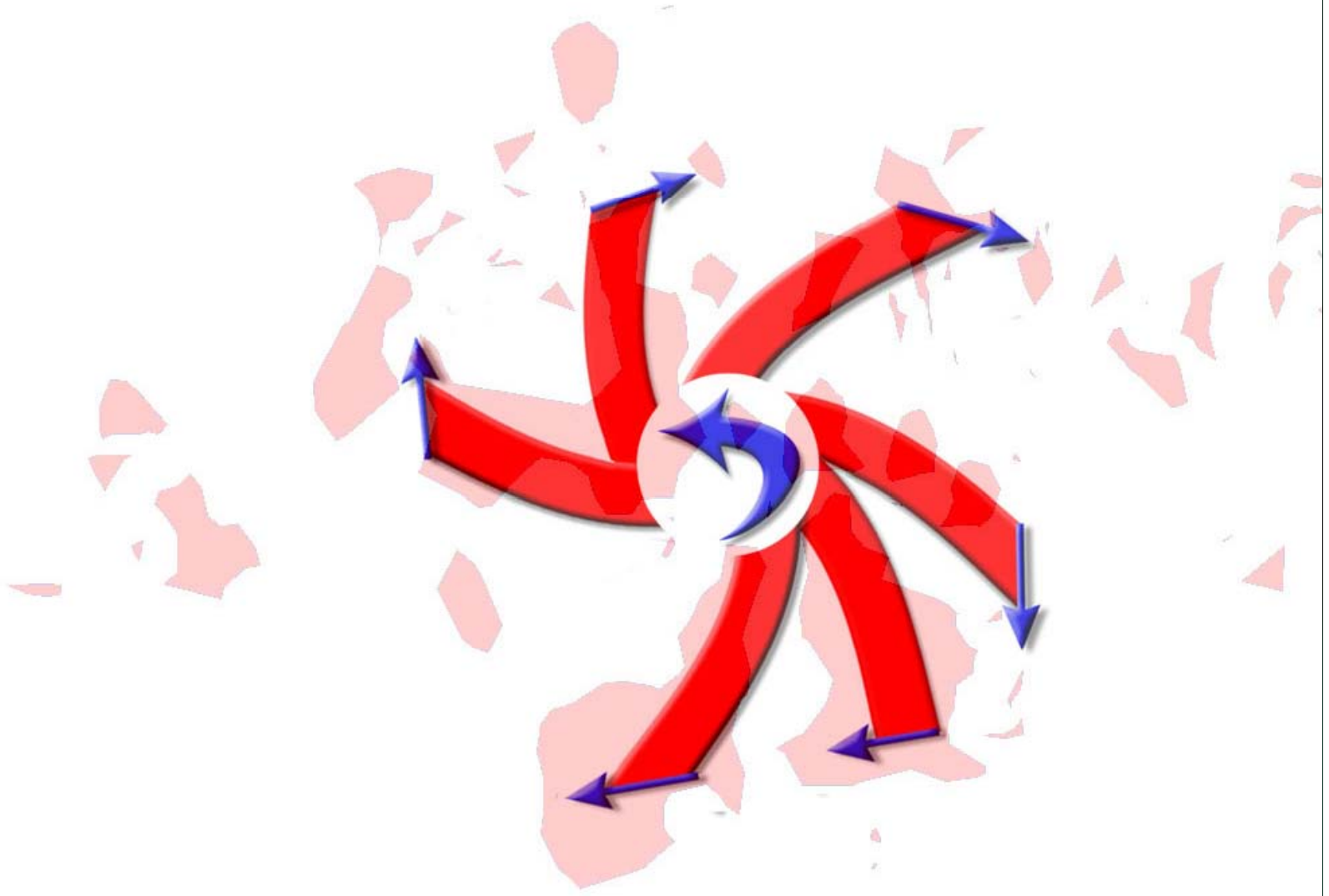


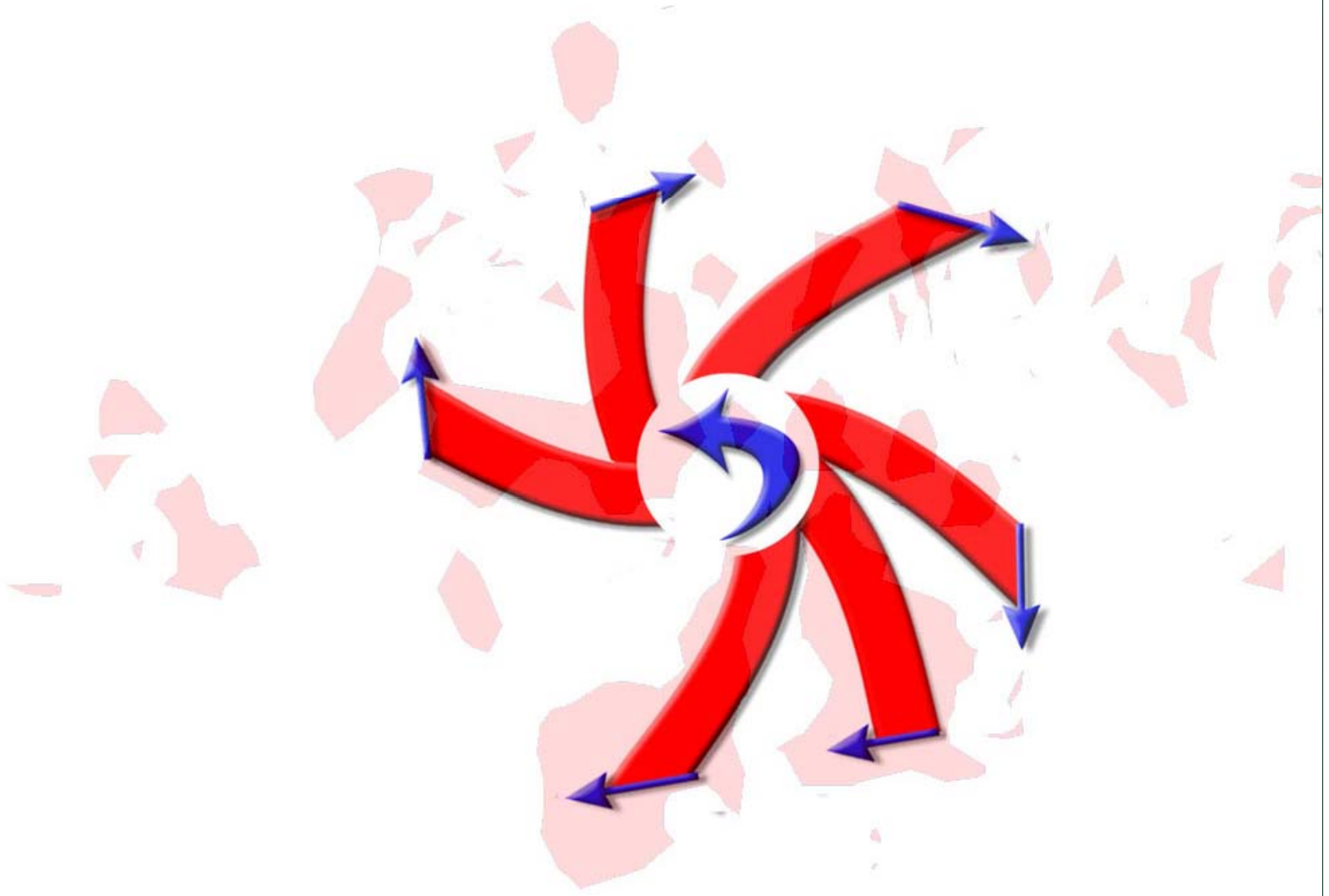


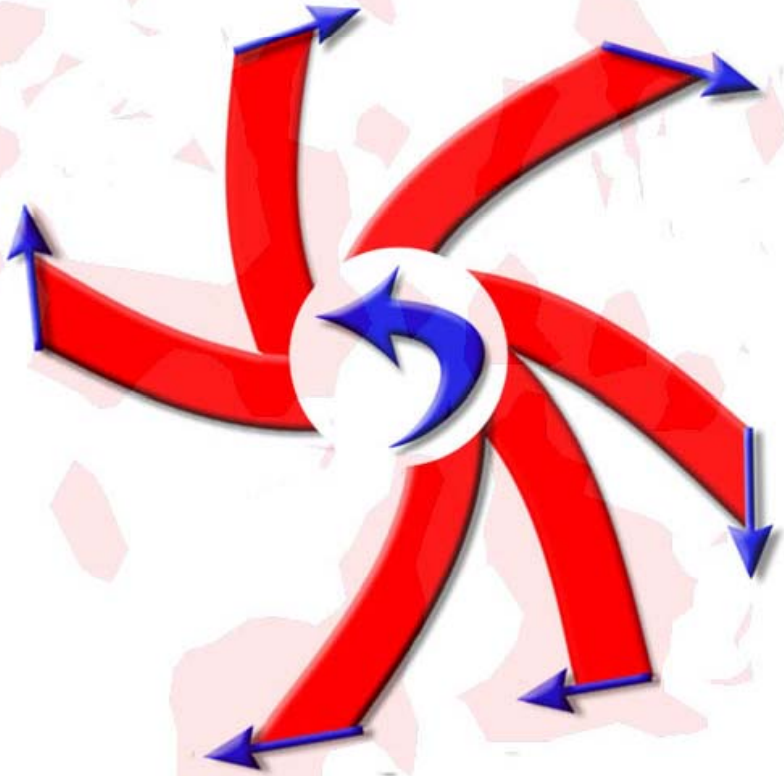


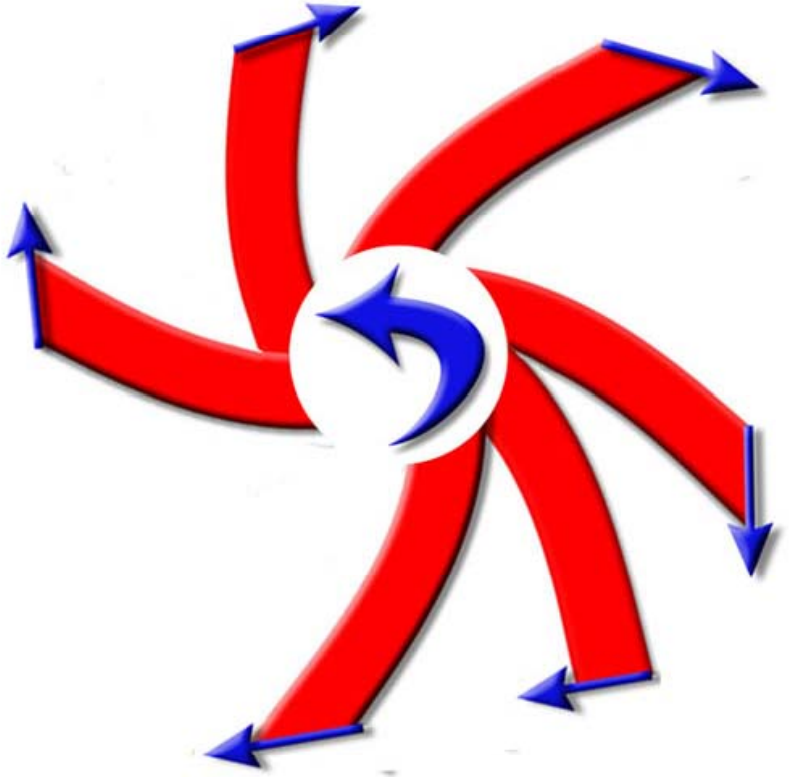




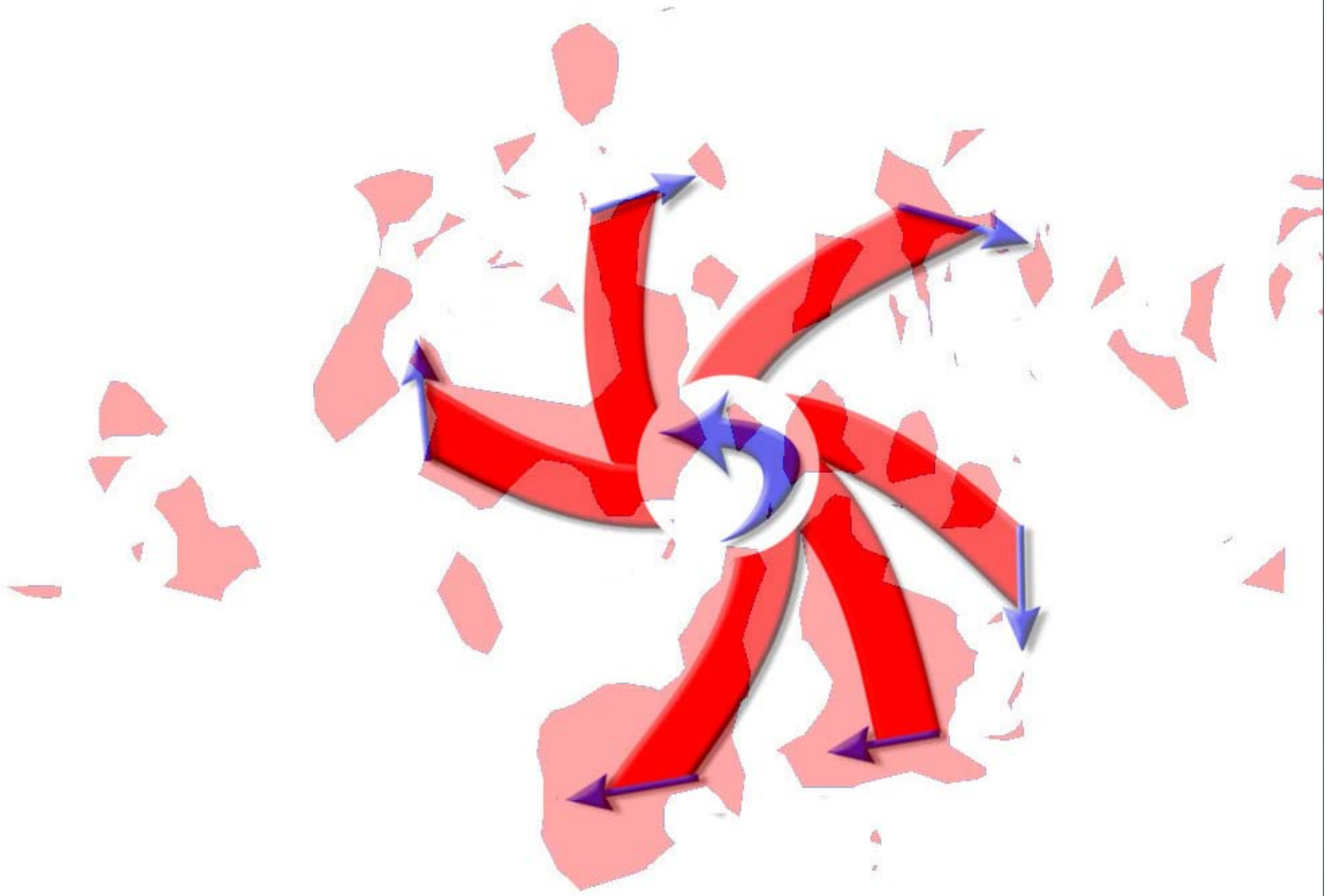






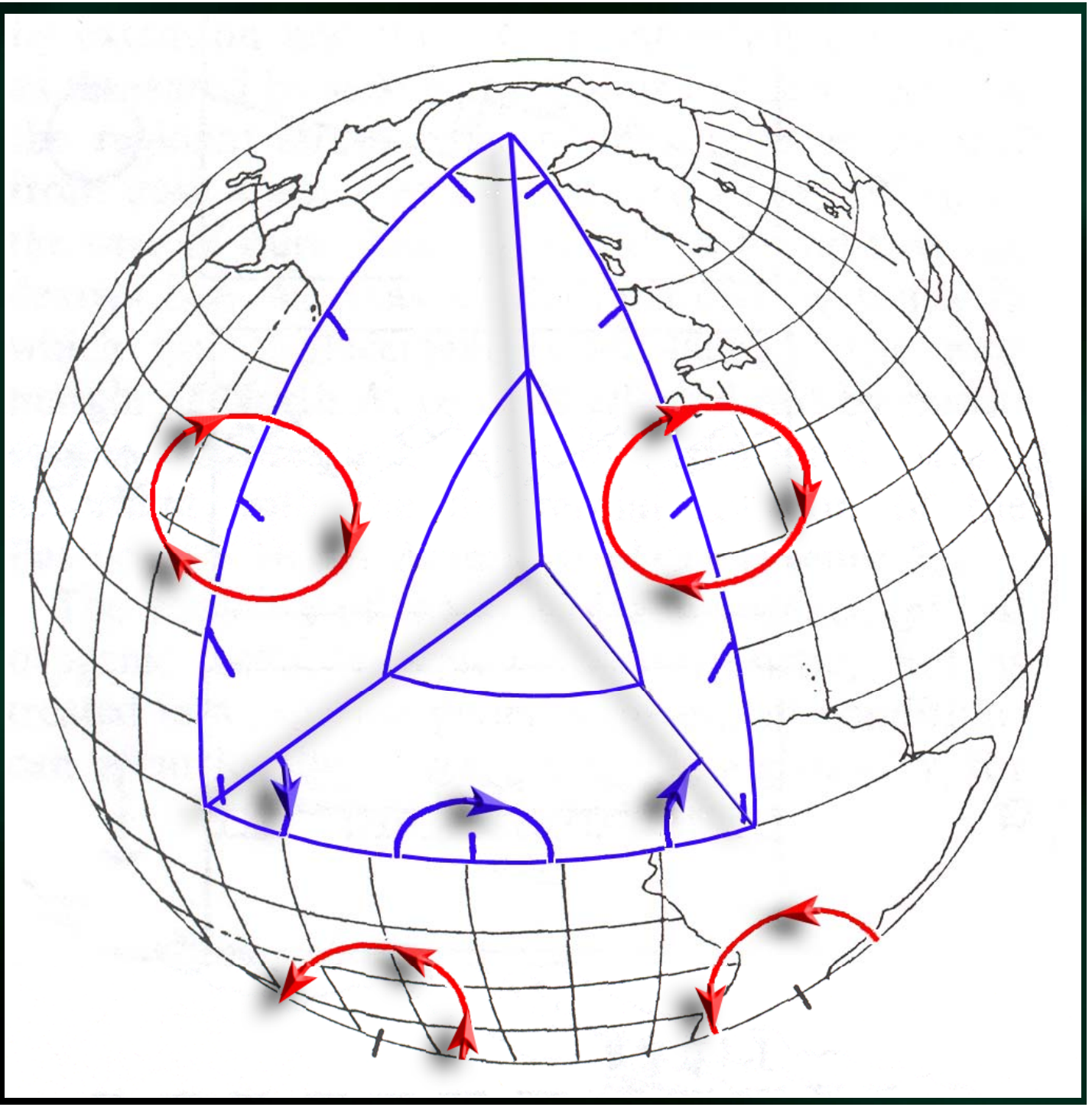


The Bendigo-Ballarat Model



Bostrom[7] shows that Earth Tide* forces acting on a convecting mantle would cause the convecting material to rotate in an anticlockwise motion in the southern hemisphere.

***Earth tide is the sub-meter motion of the Earth of about 12 hours or longer caused by Moon and Sun gravitation, These forces induce cumulative vorticity in an imperfectly elastic mantle.**

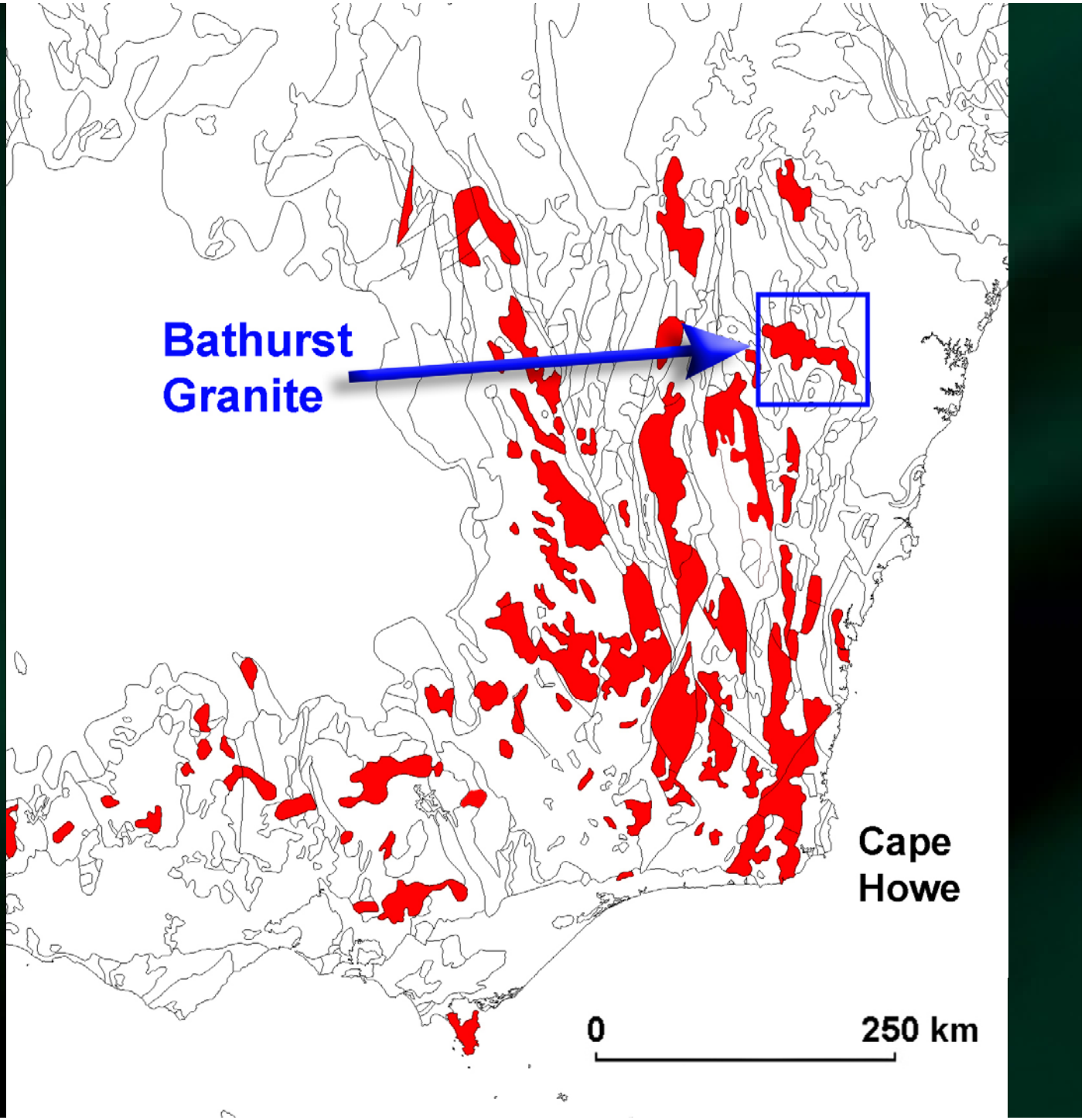


After Bostrom (2000)

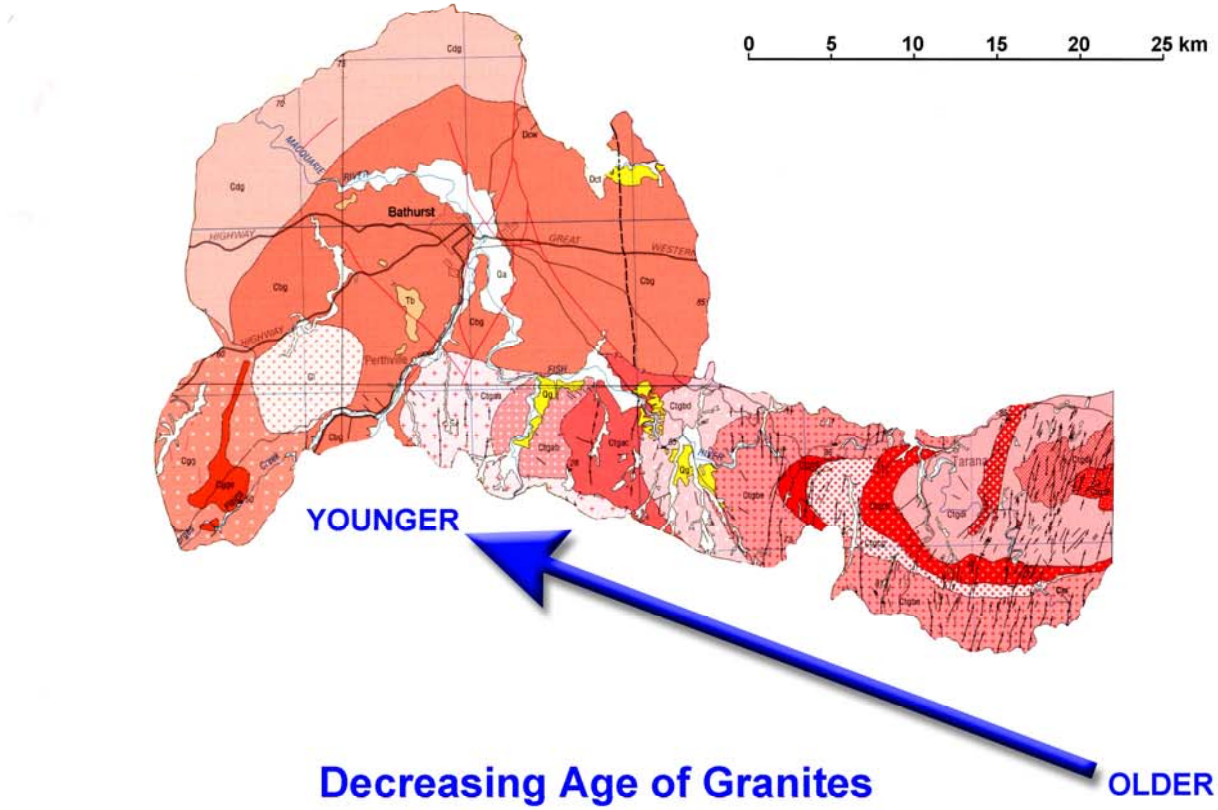
There is evidence that the entire Lachlan Fold Belt is rotating in an anticlockwise motion due to Earth Tide forces in the southern hemisphere.

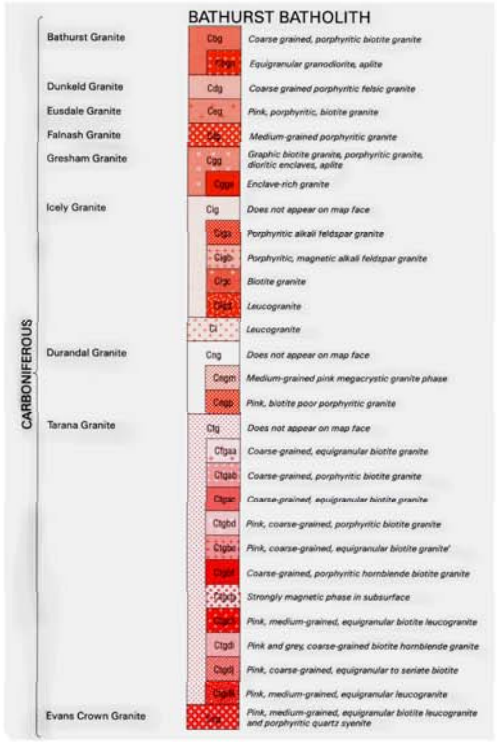
The evidence is in the geology of the Bathurst Granites.

Granites in The Lachlan Fold Belt



The Bathurst Granites





The Granites become younger to the west as would be expected if the underlying mantle is rotating in an anticlockwise direction.

See PowerPoint 6-11 Macro-Scale Patterns in Eastern Australia using Binary Slices of Gravity Data for further details on the Lachlan Fold Belt.

The End

Thank You

References

1. AGSO Geology Map of Australia, 1982

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3. Victoria Geoscientific Data CD, April 2003, Geological Survey of Victoria, Australia, 2 CD-ROM.

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5. Meyerhoff, A. A., Taner, I., Morris, A. E. L., Agocs, W. B., Kamen, K. M., Bhat, M. I., Smoot, N. C., Choi, D. R., and Hull, D. M., 1996, Surge tectonics; a new hypothesis of global geodynamics: Dordrecht, Netherlands, Kluwer, 323 p. .

6. O'Driscoll, E. S. T., 1992, Elusive trails in the basement labyrinth, *in* Rickard, -. M. J., and et al., eds., Basement tectonics 9: Australia and other regions. Proc. conference, Canberra, 1990, Kluwer, p. 123-148.

7. Bostrom, R. C., 1978, Tectonics of the tidal, convective Earth. I. Shaping of the convection in the mantle by the passage of tidal bulge: Modern Geology, v. 6, p. 171-83.

8. Bostrom, R. C., 2000, Tectonic consequences of the Earth's rotation, Oxford University Press. New York, NY, United States. Pages: 266. 2000.